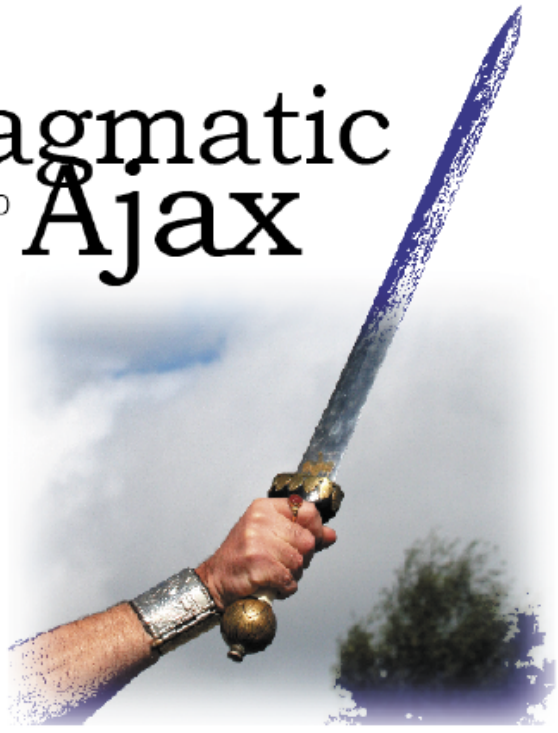
The Pragmatic Programmers

Pragmatic Ajax

A Web 2.0 Primer



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Thank you for taking part in this experiment.

► **Dave Thomas**

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Chapter 1

Building Rich Internet Applications with Ajax

This is a book about developing effective web applications. We're not going to dance around this issue. Underneath everything else, this book is about XHTML, JavaScript, CSS, and standards that have been around for almost a decade now. Not only do we admit this truth, we embrace it. Just because these standards have been around for a while doesn't mean that we can't build something new and exciting out of them. Technology, like Jello, takes a while to solidify into something tasty and satisfying.

Ajax (and Web 2.0) represents the maturation of Internet standards into a viable application development platform. The combination of stable standards, better understanding and a unifying vision amount to a whole that is greater, by far, than the sum of its parts. With Ajax, you'll be able to achieve the double Holy Grail: feature-filled user interfaces *and* a no-hassle, no-install deployment story.

It wasn't long ago that Jesse James Garrett coined the term *Ajax*. When he first released the term onto the public consciousness, it stood for *Asynchronous JavaScript And XML*. It has since, like SOAP before it, lost its acronym status and is just a word. However, it is an enormously powerful word. With this single word, Jesse James was able to harness an industry-wide trend towards richer, install-free web applications and give it focus.

Naming a thing is powerful. In this case, not quite powerful enough to become a movement, though. There was still a spark that was lacking.

It was to be provided by an entirely unlikely entity. What follows is the story of one development team, that spark, and how it changed the way we approach web software.

1.1 A Tale in Three Acts

Hector is a project manager for a web application development shop. With a long history of Perl CGI, ASP, Servlet, and JSP development under his belt, Hector has been around the block. For the last year his team has been building a CRM application for a large Fortune 500 company with offices all over the world. The application used to be a green-screen mainframe application; the company wants to take advantage of the great reach of the Internet to deploy the application to every office.

Hector and his team focus a lot of their energy on the server side of the application. They have been using one of the modern MVC frameworks from the Java community to implement the business logic; a high-performance persistence framework to access the database; messaging-based infrastructure to connect to other existing systems.

Yesterday

On the client side, Hector and his team have become masters of CSS. The look of the pages bends to their will; when the customer wants rounded corners, they get rounded corners. Rollover colors? That's easy. Multiple color schemes? No problem. In fact, Hector and his team had long ago reached a point where they weren't really worried about the user interface. See, the web operates one way: it essentially distributes static documents. When users want more data, they incur a complete interface refresh. It isn't optimal from an efficiency perspective, but it's how the web works and users have just learned to live with it.

Then, sometime a couple of weeks ago, Hector's customer came to a meeting. The customer was usually a polite, accomodating fellow. He understood the web, understood the restrictions he had to live with to get the reach of the Internet. In fact, Hector had never seen him get really angry. Until this meeting.

As soon as he walked in, the team knew something was up. He had his laptop with him, and he never carried it. As he stormed into the room, the team glanced around the table: what have we done? The customer

sat down at the table, fired up the laptop, and hammered away at the keyboard for a minute. While he pounded the keys, he told the team "Last night, my wife and I were invited to a party at the CEO's house." "Uh oh," thought the team, "this can't be good."

"Well, I certainly jumped at the chance," he continued. "I've never been before. This project got me on his radar." ("Double uh oh," thought Hector). "When I couldn't figure out how to get there with my city map, I went to the Internet. I found THIS!" He hissed the last word with venom and scorn. He flipped the laptop around so the table could see it. There, quietly couched in his browser window, was Google Maps. "Why," he said, through clenched teeth, "can't I have this?"

Today

Since that meeting, Hector and his team have been on fire to rethink the user interface. Hector went out to learn what was going on here, how Google could have completely ignored conventional wisdom and generated such a thing. He came across an article by Jesse James Garrett describing this thing called Ajax. He's been digging since then, learning everything he can about this new way of making Internet applications.

The team has begun re-implementing the UI. They're using JavaScript and DHTML techniques to provide a more dynamic experience. Most of all, they've begun taking advantage of a useful object available in modern browsers called XMLHttpRequest (XHR for short). This handy little guy lets Hector and his team request and receive fresh data from the server without reloading everything in the page.

In other words, Hector has spearheaded a move from Web 1.0 to Web 2.0. And his customer is happy again.

Tomorrow

So what comes next for Hector? His team is learning a bunch about JavaScript, and XHTML, and even more about CSS than it ever knew before. The team is really excited about the results: the user experience is just like any other application, now, except the team doesn't have to manage an installer as well as the application itself. But they've realized that there's a downside to all this.

Now, they are writing a ton of code in JavaScript. It turns out that all this page manipulation and XHR access requires a lot of real, honest-to-goodness code. And even though JavaScript LOOKS a lot like Java,

they've discovered that it really is a different beast. And now they have two codebases to manage, and test, and maintain.

So Hector is off to find out how to solve these problems. And what he will see is that most web application development frameworks are rapidly incorporating Ajax tools into their own suites. Soon, Hector and his team will be able to leverage Tapestry components, Spring tag libraries, ASP.NET widgets, Rails helpers and PHP libraries to take advantage of Ajax without having to incorporate a second way of working. The (near) future of Ajax development is total, invisible integration. Which is exactly what Hector needs.

1.2 Google Maps: The Missing Spark

Google Maps (http://maps.google.com) really ignited the Ajax fire. And Google was just about the most unlikely candidate to do it. Think about what made Google an overnight sensation in the first place: better search results, and the world's most minimal UI. It was a white page, with a text box and a button in the middle of it. It doesn't get any more minimal than that. If Google had had a soundtrack, it would have been written by Philip Glass.

When it became obvious that Google was going to enter the online mapping space, we all expected something similar. A more straightforward, less intrusive approach to viewing maps. Which is what we got; we just didn't get it the way we expected. Google, through the clever use of XHR callbacks, provided the first in-page scrollable map. If you wanted to look at the next grid of map panels, Google went off and retrieved them and just slid the old ones out of the way. No messy page refresh; no reloading of a bunch of unchanged text. Particularly, no waiting around for a bunch of ads to refresh. Just a map, the way a map ought to work.

Then we clicked on a push pin and got the info bubble. With live text in it. And a drop shadow. And that was the end of an era. We've been told the same story that you just lived through with Hector again and again. Somebody's boss or customer or colleague sees Google Maps and says "Why not me?"

As programmers, too, there's another reaction: "I wish I could work on that kind of application." There's an impression out there that Google Maps, and applications like it, are rocket science, that it takes a special kind of team, and a special kind of developer, to make it happen. This

book, if nothing else, will lay to rest that idea. As we'll demonstrate in Chapter 4, *Creating Google Maps*, on page 38 making web pages sing and dance isn't all that challenging once you know what tools are available. It becomes even more impressive once you discover that Google Maps isn't really proper Ajax; it doesn't take advantage of any of the modern asynchronous callback technology, and is really just dynamic HTML trickery.

1.3 What is Ajax?

Ajax is a hard beast to distill into a one-liner. The reason it is so hard is because it has two sides to it:

1. Ajax can be viewed as a set of technologies
2. Ajax can be viewed as an architecture

Ajax: Asynchronous JavaScript and XML

The name 'Ajax' came from the bundling of its common enabling technologies: JavaScript, XML, and an asynchronous communication channel between the browser and server. When it was defined, it was envisioned as:

1. standards-based presentation using XHTML and CSS
2. dynamic display and interaction using the Document Object Model
3. data interchange and manipulation using XML and XSLT
4. asynchronous data retrieval using *XMLHttpRequest* or *XMLHTTP* (from Microsoft)
5. JavaScript binding everything together

Although it is common to develop using these enabling technologies, it can quickly become more trouble than reward. As we go through the book we will show you how you can:

1. Incorporate Ajaxian techniques that do not use formal XML for data transport
2. Bypass the DOM APIs themselves for manipulating the in-memory page model
3. Use synchronous calls to the server, which can be powerful but is also dangerous

4. Abstract away the complexity of XMLHttpRequest

It is for these reasons that the more important definition for Ajax is...

Ajax: The Architecture

The exciting evolution that is Ajax is in how you architect web applications. Let's look first at the conventional web architecture:

1. Define a page for every event in the application: view items, purchase items, checkout, and so on.
2. Each event, or action, returns a *full* page back to the browser.
3. That page is rendered to the user.

This seems natural to us now. It made sense at the beginning of the web, as the web wasn't really about applications. The web started off as more of a document repository; a world in which you can simply link between documents in an ad-hoc way. It was about document and data sharing, not interactivity in any meaningful sense.

Picture a rich desktop application for a moment. Imagine what you would think if, on every click, all of the components on the application screen re-drew from scratch. Seems a little nuts, doesn't it? On the web, that was the world we inhabited until Ajax came along.

Ajax enables a new architecture. The important parts of this architecture are:

1. *Small Server Side Events*: Now components in a web application can make small requests back to a server, get some infomation, and tweak the page that is viewed by changing the DOM. No full page refresh.
2. *Asynchronous*: Requests posted back to the server don't cause the browser to block. The user can continue to use other parts of the application, and the UI can be updated to alert the user that a request is taking place.
3. *onAnything*: We can talk back to a server based on almost anything the user does. Modern browsers trap most of the same user events that the operating system allows: mouse clicks, mouse overs, keypresses, etc. Any user event can trigger an asynchronous request.

Figure 1.1 demonstrates the new lifecycle of an Ajax page:

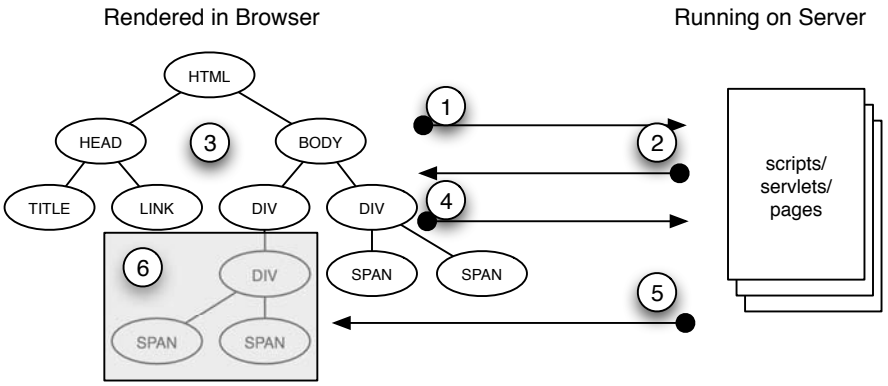

Figure 1.1: Ajax Page Lifecycle

1. User makes initial request against a given URL
2. Server returns original HTML page
3. Browser renders page as in-memory DOM tree
4. User activity causes subsequent request against another URL asynchronously, leaving existing DOM tree untouched
5. Browser returns data to a callback function inside the existing page
6. Browser parses result and updates in-memory DOM with the new data, which is then reflected on screen to the user (the page is redrawn, but not "refreshed")

This all sounds great doesn't it? With this change we have to be careful though. One of the greatest things about the web is that anybody can use it. Having simple semantics helps that happen. If we go overboard, we might begin surprising the users with new UI abstractions. This is a common complaint with Flash UIs, where users are confronted with new symbols, metaphors and required actions to achieve useful results. Usability is an important topic that we will delve into in Chapter 7, *Ajax UI, Part II*, on page 115.

1.4 Whither Now?

The rest of this book will introduce you to the breadth of the Ajax movement. We'll walk through the conversion of an application to this new style, and take a deep look at the enabling technologies behind Ajax. We'll introduce you to commonly available toolsets and frameworks that make seemingly advanced effects as simple as a single line of code. You'll get to see what your favorite development platforms are doing to take advantage of, and integrate with, this new style of development.

Most importantly, we're going to talk a lot about how to use Ajax effectively; pragmatically, even. Because the only thing worse than being left behind when the train leaves the station is getting on the wrong train. We intend this book to be a guide through a new and rapidly evolving landscape. We want to help you find out how, and even if, Ajax can help your projects. We're not trying to sell you anything (except this book). But we believe that Ajax represents a major event, and we want to be there to help you make the best of it.

Chapter 2

Ajax In Action

In the last chapter, Hector and his team went on a voyage of discovery about the possibilities for web applications. They learned that Ajaxian techniques can transform conventional web pages into dynamic web interfaces. This chapter is about lifting the veil and showing you how Ajax really works. To do this, we'll transform a traditional web page into an Ajax application right before your eyes.

2.1 Ajaxifying a Web Application

Let's consider the case of our friend Hector, the erstwhile project manager from our previous chapter. Hector released the first version of the application a few months ago. As he reviewed the user feedback, he found that some users expressed frustration with a customer data entry screen.

Figure 2.1, on the next page is a screenshot of the current version of the page.

So what's the problem with this screen? It turns out that the users of Hector's application are used to the behavior of the "green-screen" application it replaced. In the old application, all the users had to do was enter the customer's zip code and the "City" and "State" fields would auto-populate with the correct values; the users of Hector's new web application are frustrated that they now have to enter this data manually.

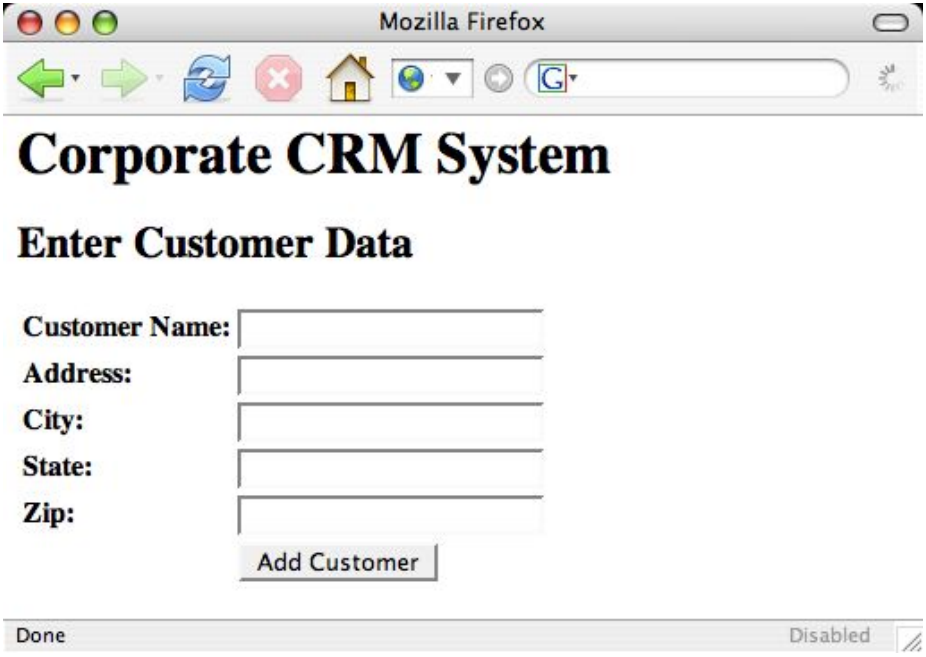

Figure 2.1: Hector's Problem Entry Screen

Grok HTML?

You know, its a bit of a tragedy that more than ten years after the web was invented, so many of us are still creating HTML by hand. Yet, here we are. A knowledge of how HTML works is essential to understanding Ajax. We're assuming a solid understanding of HTML, rather than focusing on it in this book.

2.2 Ajax to the Rescue

With Ajaxian techniques, it is possible for Hector to faithfully recreate the auto-population of data that the old green-screen application provided. Let's take a look at how this feature can be added to Hector's application.

Ajaxifying the CRM Screen

To start, let's take a look at the source code for the CRM screen.

File 1

```
<html>
    <head>
        <title>Customer Data Screen</title>
    </head>
    <body>
        <h1>Corporate CRM System</h1>
        <h2>Enter Customer Data</h2>
        <table>
            <tr>
                <th>Customer Name:</th>
                <td><input type="text" name="name"/></td>
            </tr>
            <tr>
                <th>Address:</th>
                <td><input type="text" name="address"/></td>
            </tr>
            <tr>
                <th>City:</th>
                <td><input type="text" name="city"/></td>
            </tr>
            <tr>
                <th>State:</th>
                <td><input type="text" name="state"/></td>
            </tr>
            <tr>
                <th>Zip:</th>
                <td><input type="text" name="zip"/></td>
            </tr>
            <tr>
                <th></th>
                <td><input type="Submit" value="Add Customer"/></td>
            </tr>
        </table>
    </body>
</html>
```

We want to add behavior so that when the user enters a value in the Zip field, we'll send the ZIP code to the server, receive a response containing the city and state that correspond to the ZIP, and populate the City and State fields with those values.

Preparing the HTML

event handler

The first step towards this end will be to add an *event handler* to the Zip <*input*> tag. Chances are, if you've done any HTML development before, you've dealt with event handlers; they allow you to execute script code in the web page when certain user interactivity or browser tasks occur. Secondly, we'll have to add id= attributes to the City and State <*input*> elements. You may not have had experience with id attributes; we'll talk more about those in a bit.

Our revised <*input*> elements look like this (with the surrounding table rows shown for context):

File 2

```
<tr>
    <th>Zip:</th>
    <td><input onblur="getZipData(this.value)"
               type="text" name="zip"/></td>
</tr>
<tr>
    <th>City:</th>
    <td><input id="city" type="text" name="city"/></td>
</tr>
<tr>
    <th>State:</th>
    <td><input id="state" type="text" name="state"/></td>
</tr>
```

The event handler is registered via the onblur= attribute, which in this case specifies that the script function named getZipData() will be invoked when the focus leaves this element. The parameter passed to this function, this.value, specifies that the value property of the <*input*> element will be passed; the this is a reference to the element on which the event handler has been registered.

We've also changed the ordering of the table rows; now the Zip input comes first. While this new layout is atypical for American addresses, it reflects a more natural flow for the ajaxified version of the screen, since entering the ZIP code will auto-populate the other two fields beneath it.

Communicating with the Server

We're now done with the first half of our task: wiring the HTML to a script that will perform our Ajax behavior. Now we need to tackle the slightly trickier second bit: writing the script.

The key to Ajax is a JavaScript object called XMLHttpRequest, the engine that can send HTTP requests, receive responses, and parse them as XML. Let's create our getZipData() function, which will create an instance of XMLHttpRequest and use it to send the ZIP code to the server. Remember, this function will be invoked whenever the Zip input loses focus; that is, whenever the user enters the field and then leaves it, either with the mouse, the tab key, or some other mechanism. Here's what it looks like so far:

```
Line 1   <script type="text/JavaScript">
   -         var xhr;
   -         function getZipData(zipCode) {
   -             xhr = new XMLHttpRequest();
   5             xhr.open("GET",
   -                      "/getCityStateFromZip.request?" + zipCode);
```

The Backend

We demonstrated how to request city/state data from the server, but we never showed you how the server processed the request and generated the response. Unfortunately, this can be somewhat tricky to do; what programming language should we use to demonstrate the server process? Later in the book, starting with **??**, on page ??, we talk fairly extensively about different programming language frameworks for creating server processes that can interact with Ajax web pages; for now, just take it on faith that there's a server providing data to the page.

XMLHttpRequest

The syntax we have used so far to create an instance of XMLHttpRequest is browser-specific. Microsoft's Internet Explorer, the first browser to offer this feature, uses an ActiveX component to accomplish the same tasks. Creating one requires a different syntax, which we will cover later in the book. There is talk right now that the next major release of IE (as of this writing, IE is on version 6 with Service Pack 1) will use the syntax described above, thus (hopefully, eventually) eliminating the confusion.

```
-            xhr.send(null);
-        }
-    </script>
```

So far, pretty simple, right? On line 4, we create our XMLHttpRequest instance. On the next line, we configure it using the open() function; the first parameter indicates the HTTP method to use for the request, and the second indicates the URL we'll be requesting. Finally, we invoke the send() function, which predictably enough sends the request.

Parsing the Response

Now that we've demonstrated how to send a request to the server, we need to add some code that will process the response that the server sends back. We'll do that by creating a function processZipData():

```
Line 1    function processZipData() {
```

```
-       var data = xhr.responseText;
-       var cityState = data.split(',');
-       document.getElementById("city").value = cityState[0];
5       document.getElementById("state").value = cityState[1];
-   }
```

The first few lines of this function are fairly intuitive; we retrieve the data sent back from the server—the city and state, formatted as "City,State"—and split the string into a two-element string array, so that we can access the city and state values separately.

Lines 4 and 5 demonstrate why we gave id attributes to the City and State input elements earlier. Web browsers model every web page they display as an XML document (regardless of how ugly the page's HTML markup is). In JavaScript code, we can access this XML document using the document variable. document has a handy getElementById() function that can return a reference to any XML element based on the id attribute. Once we have a reference to the element, we can manipulate it. In this case, we set the value attribute of the elements to the city and state values returned by the server.

Tying It All Together

We've created two JavaScript functions: getZipData(), which sends a request to the server, and processZipData(), which processes the response. However, we haven't yet connected them. As our code currently stands, processZipData will never be invoked.

You might think that we should invoke processZipData() as we do on line 6 of the following example.

```
Line 1  function getZipData(zipCode) {
-           xhr = new XMLHttpRequest();
-           xhr.open("GET",
-                    "/getCityStateFromZip.request?" + zipCode);
5           xhr.send(null);
-           processZipData();
-       }
```

Unfortunately, this just doesn't work. The "A" in Ajax stands for *asynchronous*, and asynchronous behavior is exactly what we're seeing here.

asynchronous

It turns out that when we invoke the send function on line 5, the invocation returns immediately and the XMLHttpRequest will make the request and receive the response on a separate thread. Thus, if we were to try to process the response from the server on the following line, we couldn't—we would not yet have received the response.

The solution is to register a *callback handler*—a function that will be invoked when the XMLHttpRequest has received the response from the server. Line 3 in the following example demonstrates how to register processZipData as a callback handler:

callback handler

```
Line 1   function getZipData(zipCode) {
    -        xhr = new XMLHttpRequest();
    -        xhr.onreadystatechange=processZipData;
    -        xhr.open("GET",
    5                 "/getCityStateFromZip.request?" + zipCode);
    -        xhr.send(null);
    -    }
```

By simply passing the name of the function to the onreadystatechange() method, we are almost ready. Why is the method named onreadystatechange() and not, say, onresponsereceived()? It turns out that XMLHttpRequest calls back into the function we registered multiple times as it sends the request and receives the response, each time indicating that it has made progress. We're only interested in parsing the data once the entire process has finished, so we need to check the current status of the XMLHttpRequest before we attempt to get the response data in processZipData():

```
Line 1   function processZipData() {
    -        if (xhr.readyState == 4) {
    -            var data = xhr.responseText;
    -            var cityState = data.split(',');
    5            document.getElementById("city").value = cityState[0];
    -            document.getElementById("state").value = cityState[1];
    -        }
    -    }
```

XMLHttpRequest provides a readyState property that indicates its current status; a state of "4" indicates that the response has been received.

The Big Picture

That's it, we're done. Let's take a look at the entire web page source code to see how all these pieces fit together:

File 2

```
<html>
    <head>
        <title>Customer Data Screen</title>
        <script type="text/javascript">
            var xhr;
            function getZipData(zipCode) {
                xhr = new XMLHttpRequest();    //<label id="code.xhr"/>
                xhr.onreadystatechange=processZipData;
                xhr.open("GET",
                         "/getCityStateFromZip.request?" + zipCode);
                xhr.send(null);
            }
```

readyState

The readyState property has five possible values:

0: (Uninitialized) the send() method has not yet been invoked.

1: (Loading) the send() method has been invoked, request in progress.

2: (Loaded) the send() method has completed, entire response received.

3: (Interactive) the response is being parsed.

4: (Completed) the response has been parsed, is ready for harvesting.

```
        function processZipData() {
            if (xhr.readyState == 4) {
                var data = xhr.responseText;
                var cityState = data.split(',');
                document.getElementById("city").value = cityState[0];
                document.getElementById("state").value = cityState[1];
            }
        }
    </script>
</head>
<body>
    <h1>Corporate CRM System</h1>
    <h2>Enter Customer Data</h2>
    <table>
        <tr>
            <th>Customer Name:</th>
            <td><input type="text" name="name"/></td>
        </tr>
        <tr>
            <th>Address:</th>
            <td><input type="text" name="address"/></td>
        </tr>
        <tr>
            <th>Zip:</th>
            <td><input onblur="getZipData(this.value)"
                       type="text" name="zip"/></td>
        </tr>
        <tr>
            <th>City:</th>
            <td><input id="city" type="text" name="city"/></td>
        </tr>
        <tr>
            <th>State:</th>
            <td><input id="state" type="text" name="state"/></td>
        </tr>
        <tr>
            <th></th>
```

```
                <td><input type="Submit" value="Add Customer"/></td>
            </tr>
        </table>
    </body>
</html>
```

Of course, Ajax is all about interactivity; seeing a code listing doesn't quite capture the drama of having the fields auto-populate. If you visit http://www.ajaxian.com/book/ajaxInActionDemo1.html you'll find an online version of this code.

2.3 The Grubby Details

Ajax doesn't seem that hard, does it? If you have much experience with HTML and JavaScript, you probably already knew how to do 90% of what we just explained. Despite what some industry figures have claimed, Ajax really isn't rocket science. However, it isn't quite as simple as we've just demonstrated, either. Before we move on, we really should stop and explain a few more things.

Cross-Browser Issues

The ajaxified web page we just looked at has at least one rather severe cross-browser limitation. The way it initializes the XMLHttpRequest object will only function on Mozilla 1.0+ and Safari 1.2+; it does not function on Internet Explorer. On IE 5.0+, the way to create it is:

```
var xhr = new ActiveXObject("Microsoft.XMLHTTP");
```

On earlier versions of Internet Explorer, the library had a different name, and the code should read:

```
var xhr = new ActiveXObject("MSXML2.XMLHTTP");
```

A common idiom for supporting all major browsers fairly easily is to use a JavaScript try/catch block to attempt to create the object in different ways:

File 3

```
function createXHR() {
    var xhr;
    try {
        xhr = new ActiveXObject("Msxml2.XMLHTTP");
    } catch (e) {
        try {
            xhr = new ActiveXObject("Microsoft.XMLHTTP");
        } catch (E) {
            xhr = false;
        }
    }
    if (!xhr && typeof XMLHttpRequest != 'undefined') {
```

```
            xhr = new XMLHttpRequest();
        }
        return xhr;
    }
```

Fortunately, these days there are a multitude of libraries that encapsulate all of this complexity into a simple, single line of code. We'll discuss some of these libraries in **??**, on page ??.

So, for all you Internet Explorer 5.0+ users, visit http://www.ajaxian.com/book/ajaxInActi for a version that's compatible with your browser.

Handling Errors

Recall the processZipData() function:

File 2
```
function processZipData() {
    if (xhr.readyState == 4) {
        var data = xhr.responseText;
        var cityState = data.split(',');
        document.getElementById("city").value = cityState[0];
        document.getElementById("state").value = cityState[1];
    }
}
```

This implementation works fairly well—until the server responds with an error. Because XMLHttpRequest uses the familiar HTTP transport to make its requests, it uses the same scheme of status codes that web developers have learned over the ages. For example, a status code of 200 indicates that the request was successfully processed, 404 indicates that the resource could not be found, and so forth.

To make our function a bit more robust, we ought to do something like this:

File 3
```
function processZipData() {
    if (xhr.readyState == 4) {
        if (xhr.status == 200) {
            var data = xhr.responseText;
            var cityState = data.split(',');
            document.getElementById("city").value = cityState[0];
            document.getElementById("state").value = cityState[1];
            document.getElementById("zipError").innerHTML = "";
        } else {
            document.getElementById("zipError").innerHTML = "Error";
        }
    }
}
```

Note the addition of a new element to the page: zipError. This is an element with an id= attribute set to zipError. When our XMLHttpRequest fails, the element will display the zen-like message "Error".

Synchronous Ajax?

We've misled you a little bit. It turns out that you don't have to use XMLHttpRequest asynchronously. When you call the open function, if you pass a third argument of falseXMLHttpRequest will make its request without spawning a background thread—thus allowing you to work with it in a synchronous fashion, such as:

```
xhr.open("GET", "/myURL", false);
xhr.send(null);
processZipData();
```

This seems so much simpler than all of that asynchronous callback mumbo-jumbo; why not use XMLHttpRequest this way?

It turns out that when you use XMLHttpRequest in this fashion, the browser's user interface becomes non-responsive for the duration of the request. If the request takes a few milliseconds, as some do, that's really not a big deal. However, when it comes to networks, one should *never* make assumptions about latency; if the request takes a second or two, the user is sure to notice. If it takes five or ten seconds, the user is sure to become rather annoyed and will perhaps even terminate the browser.

In short, you should probably never do synchronous Ajax (err, Synjax).

Network Latency

When utilizing the synchronous version of XMLHttpRequest.open one of the biggest worries you have is *latency*. You have to be concerned with the length of time it takes the response to arrive from the server, since the browser will be blocked and the user sitting idle while they wait.

latency

Less obvious, but just as important, is the effect latency can have on asynchronous requests. Take, for example, an asynchronous Ajax request which should result in several form fields being auto-populated. If the background request takes too long to return, the user might begin populating the fields by hand, expecting that some kind of error has occurred. When the results arrive from the server, what should the page do? Overwrite the user provided values, or drop the server-returned values? If it has to drop the server values, should it do so silently or with a warning?

It really doesn't matter what style of network call you utilize in your application. Network speed is always an issue on the UI, and it benefits your users when the code takes possible delays into account.

2.4 Wrapping Up

And so, armed with his new Ajax version of the customer screen, Hector is ready to satisfy his users by giving them the rich interaction they demanded. There are some ridiculously fancy Ajax websites out there, to be sure, but what you've seen in this chapter forms the foundation of all Ajaxian techniques: Asynchronous JavaScript requesting data dynamically from the server, and doing DOM manipulation of the page to dynamically update it with the new data.

As this book progresses, we'll build on this foundation to show you how to create much more advanced effects and functionality, and to do it more simply with JavaScript helper libraries and sophisticated toolkits in various programming languages.

Chapter 3

Ajax Explained

As we've discussed in previous chapters, Ajax refers to the technique of using JavaScript (specifically, the XMLHttpRequest object) to request data asynchronously, then dynamically updating a web page with the requested data. We demonstrated this technique in the last chapter by revamping Hector's CRM application to retrieve the city/state values for a ZIP code.

In this chapter, we provide a crash course in the basic techniques you'll need to master in order to implement Ajax effects of all shapes and sizes in your own applications. Though we cover the foundational technologies in this chapter, you will likely leverage frameworks with higher level abstractions. In future chapters, we discuss how third-party frameworks can give you complex effects.

In the following sections, we'll help you build a foundation of JavaScript understanding which will help you understand the technical portions of the remainder of this book. Our approach is to assume some programming experience on your part. In fact, we're betting that you're already a capable programmer in your language(s) of choice.

Our agenda for the chapter is:

- A Review of Client-side JavaScript
- Manipulating the Web Page
- Sending and Retrieving Data
- Debugging Techniques

3.1 A Review of Client-side JavaScript

Do you hate programming JavaScript? Do you consider JavaScript code inherently ugly? Do you find any non-trivial JavaScript codebase to be a maintenance nightmare? You're certainly not alone. JavaScript is widely hated and feared by many web developers, especially those with backgrounds in statically typed languages such as Java and C#.

Why do so many have it in for JavaScript? We believe that JavaScript's poor general reputation is not at all due to the syntax or capabilities of JavaScript itself. In fact, the truth of the matter is that modern JavaScript is actually a very advanced programming language. It supports continuations, closures, aspect-oriented programming, on-the-fly type modification and a host of other features found in languages like Python, Ruby, and Lisp. We think that its poor reputation stems more from its historical misuse in early web applications for cramming business logic into the view. This chapter, and this book, is about using JavaScript for its natural purpose: creating a rich user interface.

The Basics of JavaScript

Depending on your background, you may find variables in JavaScript surprising. Specifically, you don't need to declare them or define their type. Instead, you simply reference them, as in:

```
myVariable = "What am I? Who made me?"
```

In this example, the variable myVariable is automatically conjured into existence for us on the spot. This flexible manner of creating variables is neat, but also a bit confusing. Consider this next example:

```
Line 1   myVariable = 10
    -    myOtherVariable = 20
    -    mySumTotal = myVariable + myOtherVariable
    -    myVariable = 5
    5    myOtherVarable = 10
    -    mySumTotal = myVariable + myOtherVariable
```

What do you suppose the value of mySumTotal is at the end of the example? If you guessed 15, you're wrong; it's actually 25. You see, on line 5, myOtherVariable was misspelled. In a language such as Java or C#, this would produce some kind of error. In JavaScript, it's not an error at all—we've simply created a new variable on the fly named myOtherVarable. Fortunately, JavaScript does consider it an error if you reference an undefined variable in an expression. If the typo had occured

JavaScript, booleans, and You

Speaking of booleans, JavaScript can evaluate numbers and strings as booleans, too; any non-empty string and any non-zero number evaluate to true.

in line 3 or 6, as in mySumTotal = myVariable + myOtherVarable, an error would be thrown.

For this reason, we consider it good style to use the optional var keyword when declaring variables; this makes it explicit whether a variable was intended to be declared or whether a declaration is a probable typo. With var, the example looks as follows:

```
Line 1   var myVariable = 10
   -     var myOtherVariable = 20
   -     var mySumTotal = myVariable + myOtherVariable
   -     myVariable = 5
   5     myOtherVarable = 10
   -     mySumTotal = myVariable + myOtherVariable
```

JavaScript supports four basic types of values: object, number, string, and boolean (there are some others, but they aren't important just now). Unlike most other languages, JavaScript variable declarations do not declare the type of data they store. Rather, the type is determined automatically based both on what has been assigned to the variable and the type of expression in which the variable is used. What's more, JavaScript variables change their type automatically as necessary. Consider the following examples:

```
myVariable = "What am I? Who made me?"  // a string
myVariable = 42                         // now a number
myVariable = 42 + "The answer"          // a string ("42The answer")
myVariable = true                       // a boolean
```

Functions

On the surface, functions in JavaScript work much as they do in any other language. They are declared with the keyword function(), they can take zero or more parameters, and they can return values:

```
function addNumbers(one, two) {
    return one + two;
}
```

Undefined

The undefined value is a first-class type in JavaScript. Most commonly, it is the value provided by JavaScript for a variable that has been declared, but whose value has never been assigned. Some JavaScript implementations also use it for the value of variables that have never been declared, though this is less common, since most JavaScript interpreters allow for in-line variable declaration.

It is important to note that it isn't merely a value. Though it has a string representation ("undefined"), it is actually a first-class type. This means that the typeof() operator, when applied to a variable with this value, will return Undefined.

Java/C# developers may find it odd that no return type need be declared; if a function returns a value, it simply uses the return() keyword at some point. It is perfectly legal to create functions that branch and return a value in one path but don't in another. Variables that are assigned the result of a non-returning function contain the special JavaScript value undefined.

Consider this next example snippet:

```
Line 1  function myFunction(a) {
        -     return "Hello";
        - }
        -
      5 function myFunction() { // <label="code.js4.function"/>
        -     return "World";
        - }
        -
        - var myResult = myFunction("aValue"); // <label="code.js4.return"/>
```

What do you suppose the value of myResult on line is? If you are used to a language that supports method overloading, you'd probably expect the value to be Hello. In fact, it's not. JavaScript does not support overloading; that is, it doesn't match function invocations to function definitions based on both the name and parameters of the function; just the name.

Therefore, there can only be one function with a given name at runtime. If two or more functions are defined with the same name, the version that was last processed by JavaScript is invoked. In our example, that turns out to be the one defined on line .

Because a function's parameters play no role in defining it, their presense is entirely optional. In fact, there's even a way to reference an invocation's parameters without declaring them—but we'll come back to that in just a bit.

The Function Type

Earlier, we talked about the four types of values in JavaScript (object, number, string, and boolean) and hinted that more existed. Functions are in fact a type in JavaScript. In fact, once you define a function using the traditional syntax we saw earlier, a variable exists that references the function; the variable takes on the same name as the function name itself.

Consider this next example:

```
function myFunction() {
    // imagine that this function does something useful
}
alert(typeof myFunction)
```

If you execute this code in your browser, JavaScript's built-in alert function will cause a dialog to appear that displays the type of the myFunction variable; the contents of the dialog will be "function".

This particular property of JavaScript—having functions as a type—leads to some pretty interesting behaviors. Consider the following:

```
function myFunction() {  // we've created a variable myFunction
    return "Hello";      // of the type "function"
}
var myFunction = 10;     // we've now reassigned myFunction to be a number
var myResult = myFunction();  // an error -- we can't invoke a number
```

Yikes! In many languages, code like this would work just fine; variables and functions are entirely different entities and their names don't collide. In JavaScript, because functions are variables, code like this is nonsense.

In addition to the conventional syntax for defining functions that we've used up to now, there's another way to define a function:

```
var a = 10;
var b = 12;
var myFunction = function() {
    return a + b;
}
var result = myFunction();  // result is 22;
```

In this example, we've created a new function named myFunction(). The cool bit is that the function is able to access the state of its enclosing block. We can reference the a and b variables from within the function. This feature is often referred to as a closure, and it's a very powerful feature. Normally, values in the enclosing scope are lost when the scope terminates. A closure retains access to the state of the enclosing block; when used later, that state is still available to the closure.

JavaScript Events: Binding to the Web Page

Up to now, nothing of what we've considered about JavaScript is specific to web browsers. In fact, many people actually use JavaScript outside of web browsers. From here on out, however, we will start to consider properties unique to the JavaScript environment hosted in modern web browsers.

The first consideration is how web pages interact with JavaScript. If you've ever written JavaScript before, you probably know that most JavaScript in the web page must be included inside a <*script*> tag. By convention, this is typically included in the web page's <*head*> section, as in:

```
<html>
    <head>
        <script type="text/javascript">
            /* javascript code here */
        </script>
    </head>
    <body>
        // the web page contents here
    </body>
</html>
```

Actually, you can include <*script*> elements anywhere in the web page; their contents will be executed in top-to-bottom order. It is generally considered bad form to include them anywhere but in the <*head*>, however.

Defining Events

The most common way to launch JavaScript code from a web page is to use *HTML events*. These events provide hooks for web pages to execute arbitrary JavaScript code when the user interacts in certain ways with the web page. For example, in the last chapter, you saw an example of the onblur event registered on an <*input*> tag:

HTML events

```
<input onblur="getZipData(this.value)" type="text" name="zip"/>
```

JavaScript in a Web Page

We said that "most" JavaScript in a page should be included in a *<script>* tag. The exception is that JavaScript can be embedded in-line as the value of attributes on a tag. Specifically, instead of referencing JavaScript functions in event handler attributes, you can embed JavaScript directly. There is no functional difference between:

```
<div id="myDiv" onclick="clickIt();"/>
<script type="text/javascript">
   function clickIt() {
      alert("You clicked me!");
      alert("Jerk!");
   }
</script>
```

and this:

```
<div id="myDiv"
     onclick="alert('You clicked me!'); alert('Jerk!');"/>
```

As we explained back then, the onblur event is fired (that is, its contents are executed) when the user moves the cursor from the input component to some other place on the web page. In this example, the contents of the event attribute is a function invocation. As we've shown, you can place any arbitrary JavaScript code you like here, but it is a good idea to limit yourself to function invocations to keep your code a bit easier to maintain.

There are a large number of events available in a web page. These range from the so-called classic events defined many years ago in the official HTML 4 specification to some additional de facto events that have emerged in various browsers in more recent years. There are numerous resources over the web for discovering the various different types of events possible in browsers; our favorite website is QuirksMode.org[1]. QuirksMode offers a very detailed discussion of events and browsers and offers fairly recent compatibility tables for different browser types.

For your convenience, we've included a selection of important events starting on on page ??; it is by no means an exhaustive reference. As you explore the rest of this book, you'll see some additional examples.

[1] http://www.quirksmode.org

Defining Events Outside of HTML

We have so far shown that JavaScript event handler functions can be wired up to node events through HTML attributes. This is fairly common practice, though there is a class of programmer (we'll call them "purists") who frown upon this usage. Even though JavaScript is embedded within the web page itself, many developers like to consider the JavaScript and the HTML as separate artifacts. Specifically, web designers will want to work on the HTML and styles, while programmers will want to focus on the scripting. Directly embedding the JavaScript into the HTML is too much coupling.

The main alternative is to use JavaScript object properties. Once you have retrieved a reference to a node of an HTML document, it exposes its events as a series of properties. Functions can be directly attached to those properties. The following

```
<div id="mydiv" onclick="myfunc()"/>
```

is functionally equivalent to

```
<div id="mydiv"/>
<script type="text/javascript">
   document.getElementById('mydiv').onclick = myfunc;
</script>
```

The value to this technique is that the designer can worry about HTML, and only HTML. Programmers can hook events transparently. However, the downside is that the scripts that references those events must be parsed after the HTML they reference. Otherwise, the element can not be found by getElementById(), and the result is that no event is actually handled. There is a relatively new library out called Behavior (http://bennolan.com/behaviour/) that helps programmers by allowing you to assign behaviors to CSS classes, adding an extra layer of indirection.

Modern browsers support a new kind of binding. The new attachEventListener() function takes the name of the event to handle (minus the "on" part), the function pointer, and a boolean value called *capture mode*. The beauty of the new attachEventListener() method is that it can wire up multiple handlers to the same event, creating a chain of handlers. Using the direct property access, any subsequent assignments to a property just override the last assignment. Before using attachEventListener(), make sure your browser is supported. At last look, IE5+ for Windows, Firefox 1.0+ and Safari 1.2+ were all supported, but not IE for the Mac.

3.2 Manipulating the Web Page

So far, we've covered the basics of JavaScript and discussed how to get a web page to call JavaScript functions in response to user events. This covers a third of what you need to know to create an Ajax application. The next major piece is knowing how to actually change web page content from JavaScript.

XML Under the Covers

Modern browsers store a copy of every web page you visit in memory as an XML document, regardless of whether you're visiting a modern XHTML site or an old crufty HTML 2.0-era site. (When a web page isn't well-formed XML, the browser follows an internal algorithm for promoting the HTML to XML.) This in-memory XML representation of the web page can be accessed by JavaScript code to programatically determine all kinds of information about the page.

More importantly, the XML document can be modified, and such modifications are instantly reflected by the browser's rendering of that page. Thus, to achieve animation, dynamic modification, and other effects, all one has to do is modify the web page's underlying XML document. We'll now consider how to go about making such modifications.

Modifying the XML: The DOM API

The major browsers all implement the same API for exposing the XML document to JavaScript code; it's known as the DOM API. Short for Document Object Model, DOM represents XML elements, attributes, and other components as objects in memory. The DOM API models an XML document in memory as a Document object.

You can obtain a reference to the Document object that represents the current web page by simply referencing a variable named document. From this instance, you can retrieve references to individual XML elements in the web page, which are modeled as Element objects. You can also modify the attributes of an XML element via an Element object.

It's time for an example. This next code excerpt contains a simple web page that will modify itself when its button is clicked:

```
<html>
    <head>
        <script type="text/javascript">
            function modifyPage() {
                var htmlElement = document.documentElement
```

```
                var children = htmlElement.childNodes
                var bodyElement
                for (i = 0; i < children.length; i++) {
                    if (children[i].nodeName == "BODY") {
                        bodyElement = children[i]
                        break;
                    }
                }
                children = bodyElement.childNodes
                var divElement
                for (i = 0; i < children.length; i++) {
                    if (children[i].nodeName == "DIV") {
                        divElement = children[i]
                        break;
                    }
                }
                divElement.replaceChild(document.createTextNode("Goodbye, world!"),
                                        divElement.childNodes[0])
            }
        </script>
    </head>
    <body>
        <div>Hello, world.</div>
        <button onclick="modifyPage()">Click Me</button>
    </body>
</html>
```

As you can see, the DOM API is a straight-forward pleasure to use. Actually, no, it's not. The DOM API is actually quite obtuse. If you've never used the DOM API before, you might expect something that models XML in an intuitive and easy fashion. For example, you might expect to be able to, say, get a reference to the root element in your web page, the <*html*> element, and from there say something like:

```
htmlElement.getElement("BODY");
```

No such luck, my friend. You see, the DOM API models all of the different types of content in an XML file (elements, attributes, text, comments, and processing instructions) as nodes, and inexplicably, the API doesn't provide a way for you to retrieve just the element children from a parent element. This means navigating through the web page as XML is excruciating, as you can see for yourself.

Further, matters get a touch worse. Earlier we explained that browsers canonicalize all web pages—that is, convert all HTML to XML in a standard way. As part of this process, certain elements are added. For example, consider the case of an HTML table:

```
<table>
    <tr>
        <td>A table</td>
    </tr>
</table>
```

When the browser converts this HTML to XML, it automatically adds a <*tbody*> element as a child of the <*table*> element. Unexpected things happen to your HTML when the browser parses it; for this reason, you should steer clear of literally walking your page using the DOM, as things may not be where you expect them.

DOM Shortcuts

Fortunately, the DOM API includes a few shortcuts. Document objects have a method getElementsByTagName() that could have come in handy in our example. Consider this alternate JavaScript function:

```
function modifyPage() {
    var divElements = document.getElementsByTagName("DIV");
    var divElement = divElements[0];
    divElement.replaceChild(document.createTextNode("Goodbye, world!"),
                            divElement.childNodes[0])
}
```

That's much more palatable. Sure, but we still have the brittle ordering problem. We're assuming that the <*div*> element that we're interested in will always occur in the same location relative to other <*div*> elements. In our trivial example, this is a safe assumption, but in the real world, this won't work at all.

What we really need is a way to easily reference a specific element in the web page. Fortunately, there is just such an easy and convenient mechanism. If you give an element an id= attribute, you can then retrieve that element using a special function on the Document object called getElementById(). Consider this further revised version of the earlier example:

```
Line 1   <html>
     -       <head>
     -           <script type="text/javascript">
     -               function modifyPage() {
     5                   var divElement = document.getElementById("toReplace")
     -                   divElement.replaceChild(document.createTextNode("Goodbye, world!"),
     -                                           divElement.childNodes[0])
     -               }
     -           </script>
    10       </head>
     -       <body>
     -           <div id="toReplace">Hello, world.</div>
     -           <button onclick="modifyPage()">Click Me</button>
     -       </body>
    15   </html>
```

Hey, that's not looking too bad. Line 5 seems a fairly clean way to get the <*div*> we're looking for. Now, if only we could clean up the next two lines; they still seems a bit complex. And actually, we can.

The official DOM API requires that developers manually manipulate all of an element's child nodes, and add new ones, in order to change their contents. Some time ago, Internet Explorer introduced an alternative mechanism for changing the contents of an element—one that is dramatically easier to use. In recent years, Mozilla and Safari have both implemented support for this feature. Take a look at the revised modifyPage() function:

```
function modifyPage() {
    var divElement = document.getElementById("toReplace")
    divElement.innerHTML = "Goodbye, world!"
}
```

Ahh, finally—something's that easy to write! The de facto standard innerHTML property allows you to change the contents of an element by passing it a string that it will parse as XML and use to replace the current contents of the element. Nice and easy.

While the prose of these last few sections has been biased against the more traditional DOM API methods, you can choose for yourself which mechanism seems most natural to you. Some folks prefer dealing with nodes directly and actually enjoy writing code like some of the previous iterations of our example you saw. In our experience, however, most people prefer these shortcut mechanisms for retrieving elements and modifying their contents.

Attributes

So far we've talked about dealing with XML elements using JavaScript. What about attributes? Just as with elements, changes to attributes take effect immediately in the browser's view of a web page, so manipulating them can be pretty handy.

The DOM API presents a generic mechanism for manipulating attributes. Once you have a reference to an element, you can use the getAttribute() and setAttribute() functions to access and change attribute values, such as in this example:

```
var div = document.getElementById("someDiv")
div.setAttribute("style", "background: red") // make the div red
```

Surprisingly, this is fairly easy stuff. After dealing with how the DOM API treats elements, you might have expected to have to navigate through some obtuse list of attributes in order to change them. In fact, changing attribute values can be even easier than this.

Inner and Outer

The innerHTML() property that we've just demonstrated is very useful, but it has a rather storied history. It was introduced as a proprietary addition to Internet Explorer; other browsers have decided to support it as it has proved fairly useful, for obvious reasons. There are, though, two related properties: innerText(), and outerHTML().

innerText() accomplishes almost the same thing as innerHTML(). The internal representation of the referenced node is replaced with the text passed into the method. However, unlike innerHTML(), the new text is not parsed as XML. It is, rather, rendered directly as a textual child node of the containing node. This is actually a lot more performant than parsing the text as XML, and is preferable for just adding data rather than new elements to the tree.

outerHTML() is a different beast. innerHTML() detaches any and all existing child nodes of the target node, parses the new text, and adds the new nodes as children of the target (essentially, replacing everything between the opening and closing tags of the target node). outerHTML(), on the other hand, replaces the target node itself. All children of the existing node are lost as a byproduct of destroying the target node. The node is replaced with whatever new nodes are created by parsing the input to the method.

This latter approach is actually much more useful when writing web pages that are dumb shells that aggregate components. The server-side code which renders the component can return the full entity (top-level node and its children) which can be placed anywhere on the page. Using innerHTML(), the containing page has to have full control over the layout of the components, with specifically designed container nodes to use as targets. The server endpoints that render the components only output the contents of a node; if the containing page puts them in the wrong kind of node, or at the root of the document, the rendering will most likely be wrong.

Using outerHTML(), however, the server target renders the containing node AND its contents, thus ensuring that no matter where the containing page puts the results, it will be fully contained as designed. A real component, not just component contents. This sounds like an excellent thing, and it is. Except it is still a proprietary IE addition, and Firefox, for example, has not yet adopted it, and has no public plans to do so.

Cast your mind back to the CRM application we enhanced for Hector in the last chapter. Specifically, let's review a particular JavaScript excerpt that powered that application:

```
Line 1   function processZipData() {
         -      if (xhr.readyState == 4) {
         -          var data = xhr.responseText;
         -          var cityState = data.split(',');
         5          document.getElementById("city").value = cityState[0];
         -          document.getElementById("state").value = cityState[1];
         -      }
         -  }
```

Take a look at lines 5 and 6. What's that .value bit? What that's actually doing is changing the value attribute for the city input element. Given what we just talked about a few paragraphs ago, we ought to accomplish that using the setAttribute() function, as in setAttribute("value", "city"). What's that value property all about?

It turns out that the DOM API also defines a standard for mapping specific attributes from the HTML grammar directly into the a special extended version of the DOM API that browsers supply. Using these special extensions, you can set an attribute's new value by modifying a property of the element itself. Thus, when getElementByID("city") returns an input element, we can change its value attribute just by setting the value property on the object. Nifty!

3.3 Retrieving Data

We've talked about JavaScript, we've talked about how to manipulate the web page with the DOM API, so we're just missing one key element to explain Ajax: retrieving data. The heart of data retrieval is the XMLHttpRequest object (XHR for short) that we introduced in the last chapter. In this section, we'll discuss more details about XHR.

XMLHttpRequest

In the previous chapter, we saw the basics on how to create an instance of an XHR and use it to retrieve data. Let's review that again here, briefly, in the context of a different example. The following code listing shows how a simple web page can retrieve a message from a server and display it.

```
Line 1   <html>
         -      <head>
         -          <script type="text/javascript">
         -              var xhr;
```

```
5
-               function modifyPage() {
-                   try {
-                       xhr = new ActiveXObject("Msxml2.XMLHTTP");
-                   } catch (e) {
10                      try {
-                           xhr = new ActiveXObject("Microsoft.XMLHTTP");
-                       } catch (E) {
-                           xhr = false;
-                       }
15                  }
-
-                   if (!xhr && typeof XMLHttpRequest != 'undefined') {
-                     xhr = new XMLHttpRequest();
-                   }
20
-                   xhr.open("GET", "/message");
-                   xhr.onreadystatechange=function() {
-                       if (xhr.readyState != 4) return;
-
25                      document.getElementById("message").innerHTML = xhr.responseText;
-                   }
-                   xhr.send(null);
-               }
-           </script>
30      </head>
-       <body>
-           <div id="message"></div>
-           <button onclick="modifyPage()">Click Me</button>
-       </body>
35  </html>
```

This HTML will render a very simple web page that presents a button to the user. Once clicked, the page will display the results of a query to the server in the page above the button. Line 21 shows the requested URL as "/message"; you could implement this URL using any web-enabled language. A Java Servlet implementation would look something like this:

```
import javax.servlet.http.*;
import javax.servlet.ServletException;
import java.io.IOException;
import java.util.Date;
public class MessageServlet extends HttpServlet {
    protected void doGet(HttpServletRequest request,
                         HttpServletResponse response)
     throws ServletException, IOException {
        response.getWriter().println("Hello world; the current time is " + new Date());
    }
}
```

But really, you could also implement the message URL as a flat file containing plain text or an HTML snippet; it really doesn't matter. XHR requests the URL just like the browser would, and returns the results just as though you entered the URL in the browser URL field.

XHR in Detail

Let's talk about some of the other features of XHR that we haven't covered thus far.

States

The onreadystatechange property is a key feature of XHR. It lets you register an asynchronous callback handler that will be invoked as the state of XHR changes during a request/response communication with a server. In the last chapter, we looked at the five possible states of the readyState property. Generally speaking, the important state is 4 (Completed). The other four states are all different shades of "incomplete".

Headers

In addition to exposing somewhat granular information about its current state, XHR also lets you modify or add HTTP headers in the request and view headers in the response. This is accomplished using the setRequestHeader(), getResponseHeader(), and getAllResponseHeaders() functions. In this example, we spoof the browser used to send the XHR:

```
xhr.setRequestHeader("User-Agent", "My Custom Browser");
```

Response Data

In the examples, we've used the responseText() property to retrieve the response body from the server. There's another property, responseXML(), that returns the response from the server as a DOM instance. This can be useful if you want to send structured data back to the web page from the server; you can use the DOM API to navigate through the data as XML and update the web page as appropriate based on that data.

3.4 Summary

This chapter dives into the underpinnings of Ajax. You've seen the JavaScript language and DOM model up close and personal. Though it is certainly possible to write applications using only the constructs you've seen here, programmers generally tend to appreciate tools that give them more leverage. After we tackle implementing Google Maps, the next several chapters will look at the frameworks that have sprouted

lately to make the gory details of DOM manipulation, event binding and node traversal disappear.

Chapter 4

Creating Google Maps

For many of us, Google Maps (http://maps.google.com) ignited the Ajax revolution. While ajaxian techniques had been creeping into mainstream websites long before Google Maps, nothing in recent memory presented commodity browsers with such a visually impressive experience. Google Maps showed the world that a wide world of potential lay hidden in the technologies we thought we understood so well.

The purpose of this chapter is to lay bare the techniques that Google used to wow us all with Google Maps. What we'll discover here is fascinating and important; it also might be more than you want to bite off right now. If so, don't worry about skipping ahead to the rest of the book and coming back here later; we won't mind.

4.1 Rocket Scientists?

Shortly after Google Maps launched, entrenched commercial interests who relied upon the staidness of standard HTML-based web interfaces to make money were quick to claim that mainstream HTML developers need not attempt to create web interfaces like Google Maps. The CEO of Macromedia, maker of the popular Flash browser plug-in, stated in at least one interview that such non-Flash web interfaces required the skills of "rocket scientists." (Ironically, when Macromedia finally produced a clone of Google Maps in Flash four or five months later, it failed to function on the two Mac laptops we used to try it out—actually locking up the browser. Google Maps works just fine on both machines. We're actually not anti-Flash; we just found it ironic, that's all.)

Such statements have added to the general impression many developers have that creating something like Google Maps is just, well, hard.

In fact, some developers have even felt a little fear and intimidation—fear that someday soon, they'll be asked to create something like Google Maps!

Certainly many of us who have been writing HTML for years might like to believe that it took a team of rocket scientists to produce a litany of innovations supporting the technologies behind the Google Maps interface, if nothing else to provide an excuse as to why we haven't been writing apps like that all this time. However, we believe all this business about rocket science and intimidation is a bit exaggerated.

In fact, after spending ten minutes examining Google Maps a bit deeper, we realized that, far from being the product of rocket scientists, the Google Maps interface is actually fairly straight-forward to implement. Perhaps, some might say, easy. Not "same-amount-of-effort-as-a-PHP-web-form" easy, but we were able to implement something a great deal like it in about two hours. Not just any two hours mind you; two hours of sitting in a crowded convention center during a technical conference whilst being interrupted by our friends every few minutes.

So while there's no doubt Google has recently hired some of the most visible computer scientists—perhaps the closest examples of "rocket scientist"-like brainpower in our industry, like Adam Bosworth (famed Microsoft innovator), Joshua Bloch (famed Java innovator at Sun Microsystems), and Vint Cerf (famed Internet innovator)—we're pretty sure they weren't involved in the creation of the Google Maps interface. The reality is if we can create an interface like Google Maps in a couple of hours, imagine what a few capable web developers could do in a few weeks or a month.

4.2 Your Own Google Maps

In fact, we'll spare you from putting your imagination to the test. Let us show you first-hand how you can create your own version of Google Maps. In the next few pages, we'll walk you through the creation of "Ajaxian Maps," our own derivative of the big GM. We'll start out by explaining how the Google Maps user interface works.

Google Maps Deconstructed

We're going to break down the elements of Google Maps one by one. Let's start out with the most dramatic feature: the big scrolling map, the heart of the application.

The Real Rocket Science

Okay, okay we admit—it isn't easy to create something like Google Maps. The geocoding features behind the scenes that map addresses to locations on a map, that normalize a maps features against satellite imagery to such an amazing degree that they can be overlaid on top of each other and look relatively accurate, and the plotting of routes from Point A to Point B is all incredibly non-trivial.

However, we maintain that it's not the geocoding features of Google Maps that is particularly innovative or impressive. MapQuest and other software packages have been doing this kind of work for years. No, what's impressive about Google Maps is the *web interface* on top of the geocoding engine. And it's that interface that we find easy, not the geocoding under the covers.

As our good friend Glenn Vanderburg says, though: "*Technically* it's easy, but the *conception* Fof this kind of interface is the really amazing part, just having the idea and then realizing that it could be done. So many things are simple once you've seen that they're possible." The take home lesson is that Google Maps shows that once you have conceived of your next great UI idea, you can take comfort in knowing that the technical solution to implementing it might not be so daunting.

The Map

As you know, the map works by allowing you to interactively move the map by dragging the map itself using the mouse. We've seen mouse dragging in browsers for years, but the impressive bit is that the scrolling map is massive in size, can have the zoom level and so forth. How do they do that?

Of course, the browser could never fit such a large map in memory at once. For example, a street-level map of the entire world would probably be about a million pixels square. How much memory would it take to display that map? For the sake of conversation, let's assume that the map is displayed with just 256 colors, meaning each pixel would consume just one byte of memory per pixel. Such a map would require 1,000,000,000,000 bytes of memory, or roughly one thousand gigabytes of RAM. So, simply displaying an <*img*> element just isn't

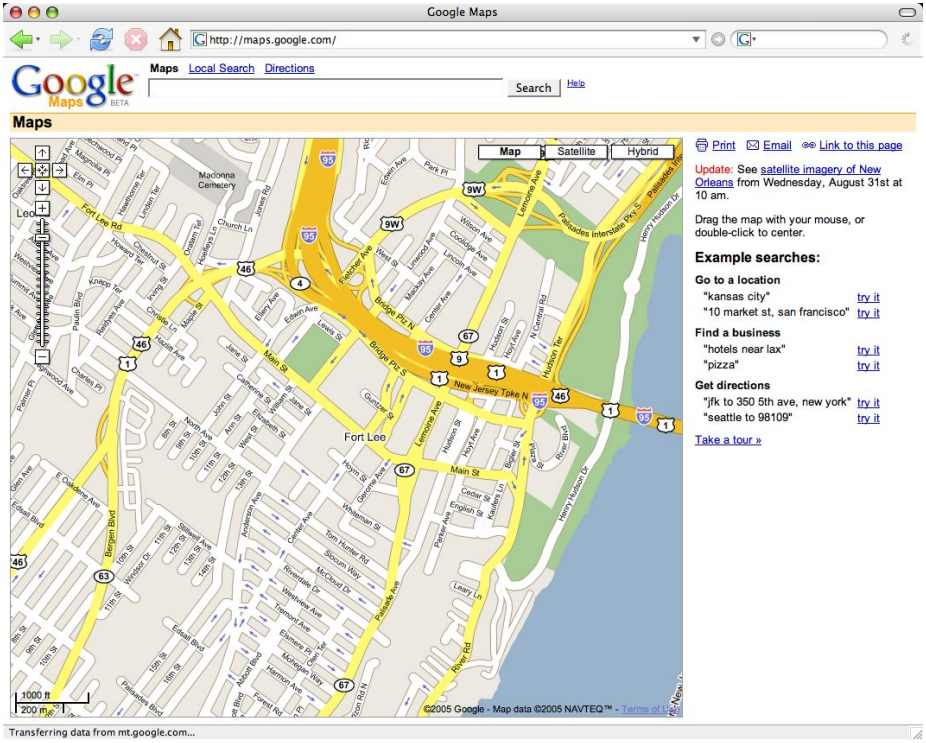

Figure 4.1: Google Maps

going to work.

What the Googlers do to work around the paltry amount of memory our desktop PCs have is split up the map into various tiles. These tiles are laid out contigously to form one cohesive image. An example of these tiles is shown in Figure 4.2, on the next page. While the size of these tiles has changed, the current size is 250 pixels square.

The tiles themselves are all laid out within a single HTML div element, and this div element is contained within another div; we'll call these two divs the *inner* and *outer* divs, respectively.

We mentioned just a moment ago that the browser couldn't fit the entire map image in memory. Of course, dividing a single map into an arbitrary number of tiles and then displaying all those tiles at once would consume an equal amount of memory as the entire image. To compensate for memory limitations, Google Maps virtualizes the grid of tiles

More Than A Million Pixels

We say in "The Map" section that a street-level map of the world would be about a million square pixels. Actually, that number's a wild underestimate. At Google's highest level of magnification, a square mile consumes about 7,700,000 pixels. The Earth is estimated to contain 200,000,000 square miles, but only 30% of that is land, so let's reduce the number to 60,000,000 square miles.

Multiplying the number of pixels by the number of square miles in the Earth produces the mind boggling number of 462 million million pixels, which at 16.7 million colors (the color depth of any modern home computer) would consume at least three times that amount of memory in bytes. Of course, most image viewing programs have some sort of paged memory subsystem that views a portion of the image at any one time, but you get the idea...

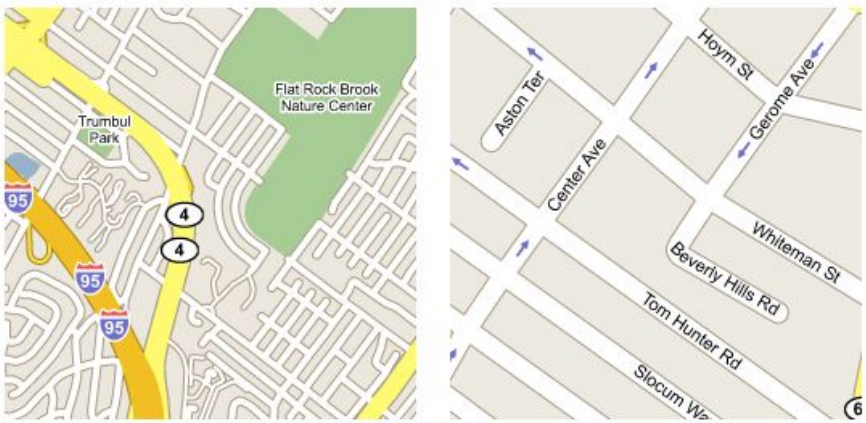

Figure 4.2: Google Maps Tiles

in memory and only displays the set of tiles that the user can see, in addition to a few additional tiles outside of the viewing area to keep the scrolling smooth.

If this whole grid virtualization mish-mash sounds a little complex, don't worry, it's fairly straight-forward, though it is the most complicated bit of the UI.

Zoom Level

Another key feature of Google Maps is the ability to zoom in and out, enlarging or reducing the size of the map, letting you get a view of the entire world at one moment, and a view of your street the next. This is actually the simplest of the features to implement. Changing the zoom level just changes the size of the tile grid in memory as well as the URLs of the tile images that are requested.

For example, the URL to one of the tiles in the screen shot is `http://mt.google.com/mt?v=w2.` By changing the value of the last parameter, "zoom=3", to another value, such as "zoom=1", you can retrieve a tile at a different zoom level. In practice, it's not quite that simple because the grid coordinates change rather a great deal with each zoom level and they often become invalid.

How do they get the zoom level to constantly hover over the map in a constant position? The zoom level widget is an image embedded in the outer div, and makes use of transparency to blend in with the map image.

Push Pins and Dialogs

Another neat-o feature are the push pins and dialogs that appear after a search. Figure 4.3, on the following page shows a screenshot with these elements present. These are especially cool because they both include these rounded edges and shadows that make them blend in with the background map in a sophisticated fashion.

We said the zoom level was the easiest feature, and frankly, we were probably wrong. This is ridiculously easy. The push pins and dialogs are simply a PNG image. The PNG image format is supported by the major browsers and supports a nice feature called *alpha transparency*. Alpha transparency allows for more than just the simple transparency that GIF images support; it allows a pixel to be one of 254 different

alpha transparency

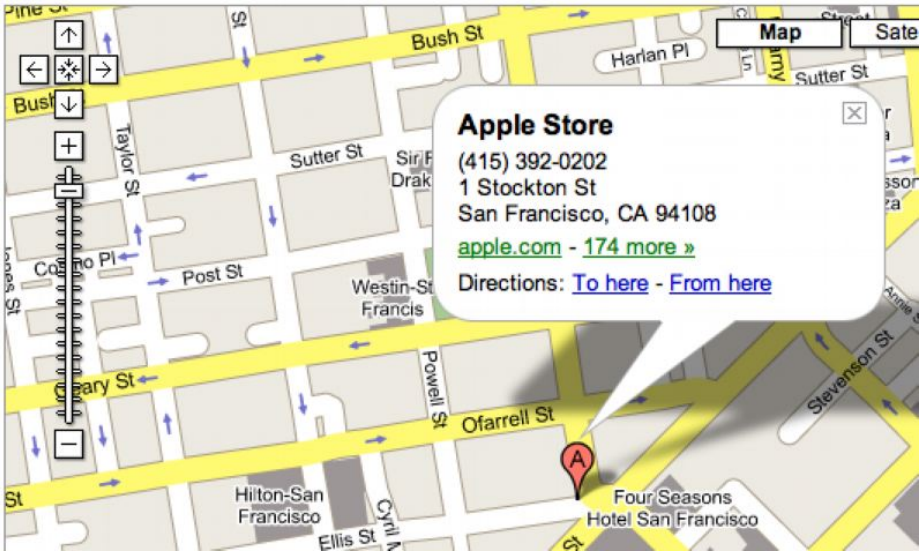

Figure 4.3: The Google Maps Push Pin and Dialog

values in-between fully transparent and fully opaque, and its this gradient transparency support that allows the push pins and dialog to use a shadow that blends in with the map.

Showing these features is simply a matter of positioning images in the inner div at an absolute position.

Feature Review

There are other features, of course. But we'll stick to the set of features we've enumerated; we think these represent the vast majority of the "ooh, ahh" factor. In review, they were:

- *The scrolling map.* This is implemented as an outer div containing an inner div. Mouse listeners allow the inner div to be moved within the confines of the outer div. Tiles are displayed as img elements inside the inner div, but only those tiles necessary to display the viewing area and a buffer area around it are present in the inner div.
- *The zoom level.* This is an image embedded in the outer div. When clicked, it changes size of the grid representing the tiles,

and changes the URL used to request the tiles.

- *The push pins and dialogs.* These are PNG images with alpha transparency that are placed in absolute positions within the inner div.

Now that we've deconstructed Google Maps a bit, let's set about implementing it.

4.3 Creating Ajaxian Maps

Because Ajaxian Maps won't bother with all of that geocoding mumbo jumbo, all of our heavy lifting will be in JavaScript. However, we will use Java to provide some server features and a few image manipulation tasks. While all of the code for Ajaxian Maps will be included in this chapter, you can also download the code from our website at http://www.ajaxian.com/pragajax/ajaxianmaps/.

IE 6, Firefox 1.x, and Safari 2.x Only

We've tested this version of Ajaxian Maps in the three major browsers, but haven't bothered with older versions and more obscure browsers (sorry, Opera users). It should work on older platforms, but without testing, we can't be sure we've caught everything.

Step 1: Create a Map

The first step in displaying a map is, err, creating it. While we could simply steal the wonderful map that Google Maps uses, Google might not appreciate that. So, we'll go ahead and use a map that is explicitly open source. The Batik project (`http://xml.apache.org/batik`), an open-source Java-based SVG renderer, comes with an SVG map of Spain. We'll go ahead and use that.

Because most browsers don't provide native support for SVG, we'll need to convert the map to a bitmap-based format. Fortunately, Batik can do that for us. One of the nice things about SVG is that it can scale to arbitrary sizes, so we could conceivably create a huge image for our map. However, creating truly huge images is a little tricky, because due to memory limitations, we'd have to render portions of the SVG image and generate our tiles over the portions and have some sort of scheme for unifying everything together. To keep this chapter simple, we'll just go ahead and limit our map to 2,000 pixels in width and 1,400 pixels

in height. In order to implement zooming, we'll also generate a smaller image that represents a view of map in a zoomed out mode.

The following code excerpt shows how to use Batik to convert the map of Spain into both a 2000x1400 pixel JPG file and a 1500x1050 pixel JPG file:

File 25

```
package com.ajaxian.amaps;

import org.apache.batik.apps.rasterizer.DestinationType;
import org.apache.batik.apps.rasterizer.SVGConverter;

import java.io.File;

public class SVGSlicer {
    private static final String BASE_DIR = "resources/";

    public static void main(String[] args) throws Exception {
        SVGConverter converter = new SVGConverter();

        // width in pixels; height auto-calculated
        converter.setWidth(2000);
        converter.setSources(new String[] { BASE_DIR + "svg/mapSpain.svg" });
        converter.setDst(new File(BASE_DIR + "tiles/mapSpain.jpg"));
        converter.setDestinationType(DestinationType.JPEG);
        converter.execute();

        converter.setWidth(1500);
        converter.setDst(new File(BASE_DIR + "tiles/mapSpain-smaller.jpg"));
        converter.execute();
    }
}
```

To compile the code, you'll need to put the Batik JARs in your classpath, and place the source code in the following directory hiearchy: com/ajaxian/amaps. Figure 4.4, on the next page shows what either map JPG file should look like. You can also replace the value of the BASE_DIR variable with whatever is most convenient for you.

Step 2: Create the Tiles

Now that we have a map at two different zoom levels, we need to slice it up into tiles. This is pretty easy with the nice image manipulation libraries available in many programming languages. We'll demonstrate how to do that with Java here:

File 24

```
package com.ajaxian.amaps;

import org.apache.batik.apps.rasterizer.DestinationType;
import org.apache.batik.apps.rasterizer.SVGConverter;

import javax.imageio.ImageIO;
import java.io.File;
import java.awt.*;
import java.awt.image.BufferedImage;

public class ImageTiler {
    private static final String BASE_DIR = "resources/";
    private static final int TILE_WIDTH = 100;
    private static final int TILE_HEIGHT = 100;
```

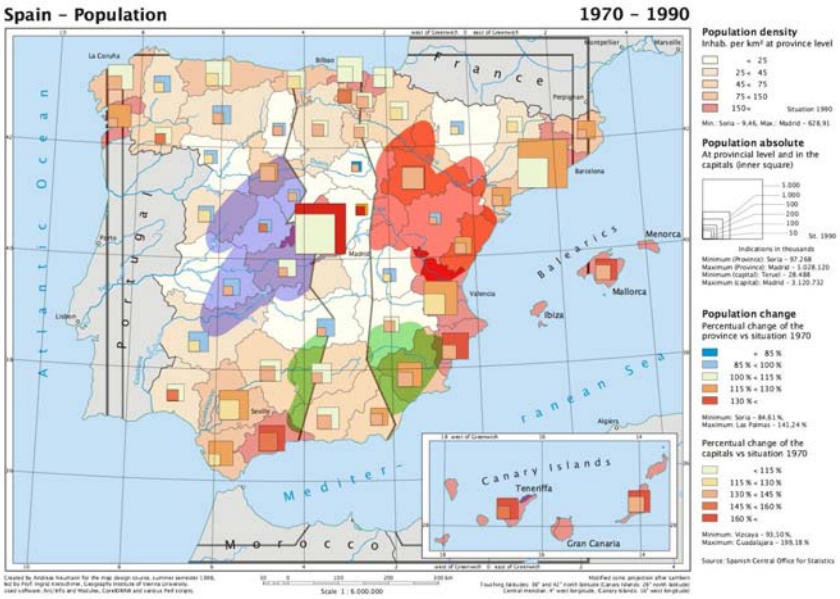

Figure 4.4: Batik's SVG Spain Map

```
public static void main(String[] args) throws Exception {
    // create the tiles
    String[][] sources = { { "tiles/mapSpain.jpg", "0" },
            {"tiles/mapSpain-smaller.jpg", "1"} };
    for (int i = 0; i < sources.length; i++) {
        String[] source = sources[i];
        BufferedImage bi = ImageIO.read(new File(BASE_DIR + source[0]));
        int columns = bi.getWidth() / TILE_WIDTH;
        int rows = bi.getHeight() / TILE_HEIGHT;
        for (int x = 0; x < columns; x++) {
            for (int y = 0; y < rows; y++) {
                BufferedImage img = new BufferedImage(TILE_WIDTH, TILE_HEIGHT,
                        bi.getType());
                Graphics2D newGraphics = (Graphics2D) img.getGraphics();
                newGraphics.drawImage(bi, 0, 0, TILE_WIDTH, TILE_HEIGHT,
                        TILE_WIDTH * x, TILE_HEIGHT * y,
                        TILE_WIDTH * x + TILE_WIDTH,
                        TILE_HEIGHT * y + TILE_HEIGHT,
                        null);
                ImageIO.write(img, "JPG", new File(BASE_DIR + "tiles/" +
                        "x" + x + "y" + y + "z" + source[1] + ".jpg"));
            }
        }
    }
}
```

```
}
```

Note that to make things interesting, we made our tile size a bit smaller than Google maps: 100 pixels square. We chose x0y0z0.jpg as the naming convention for the tiles, where the zeros are replaced with the x and y grid coordinates (0-based) and the zoom level (0 or 1; 0 is for the bigger of the two maps).

Step 3: Creating the Inner and Outer Divs

Now that we have the image tiles, we can start building our map UI. We'll start out with a simple web page, shown here:

File 26

```
<html>
    <head>
        <title>Ajaxian Maps</title>
        <style type="text/css">
            h1 {
                font: 20pt sans-serif;
            }
            #outerDiv {
                height: 600px;
                width: 800px;
                border: 1px solid black;
                position: relative;
                overflow: hidden;
            }
        </style>
    </head>
    <body>
        <p>
            <h1>Ajaxian Maps</h1>
        </p>
        <div id="outerDiv"> <!-- <label id="step3.1.outer.div"/> -->
        </div>
    </body>
</html>
```

A screenshot of this page is shown in Figure 4.5, on the following page. Pretty simple so far. Let's get to the good stuff. The div on will become what we've called the outer div. Let's start out by giving it an inner div with some simple content.

File 27

```
<html>
    <head>
        <title>Ajaxian Maps</title>
        <style type="text/css">
            h1 {
                font: 20pt sans-serif;
            }
            #outerDiv {
                height: 600px;
                width: 800px;
                border: 1px solid black;
                position: relative;
```

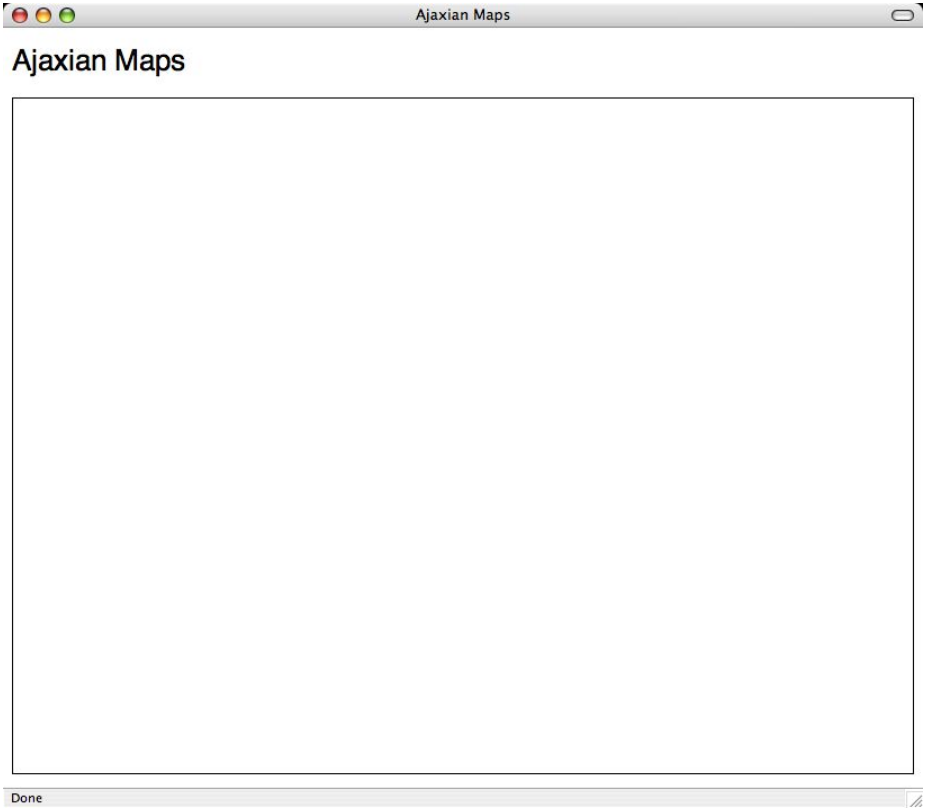

Figure 4.5: Humble Beginnings

```
                overflow: hidden;
            }
            #innerDiv {
                position: relative;
                left: 0px;
                top: 0px;
            }
        </style>
    </head>
    <body>
        <p>
            <h1>Ajaxian Maps</h1>
        </p>
        <div id="outerDiv">
            <div id="innerDiv">
                The rain in Spain falls mainly in the plains.
            </div>
        </div>
    </body>
</html>
```

Now we need to make the inner div large enough to contain all of the image tiles. We could just size a style on the inner div to make it some arbitrary size, as in * *, but we'll do this via JavaScript. Why? Well, because we'll implement the ability to change zoom levels a little later, we know we'll have to change the size of the inner div dynamically anyway, we might as well start out that way. We'll use an onload JavaScript handler to initialize the size of the inner div once we load the page. Check out the code:

File 28

```
<html>
    <head>
        <title>Ajaxian Maps</title>
        <style type="text/css">
            h1 {
                font: 20pt sans-serif;
            }
            #outerDiv {
                height: 600px;
                width: 800px;
                border: 1px solid black;
                position: relative;
                overflow: hidden;
            }
            #innerDiv {
                position: relative;
                left: 0px;
                top: 0px;
            }
        </style>
        <script type="text/javascript">
            function init() {
                setInnerDivSize('2000px', '1400px')
            }
            function setInnerDivSize(width, height) {
                var innerDiv = document.getElementById("innerDiv")
                innerDiv.style.width = width
                innerDiv.style.height = height
            }
        </script>
    </head>
    <body onload="init()">
        <p>
            <h1>Ajaxian Maps</h1>
        </p>
        <div id="outerDiv">
            <div id="innerDiv">
                The rain in Spain falls mainly in the plains.
            </div>
        </div>
    </body>
</html>
```

Okay, now we've got an inner div big enough to display the tiles for the largest of our two maps. Now we need to add the dragging functionality.

Step 4: Dragging the Map

We'll implement dragging as a series of three different mouse event listeners. When the user presses the mouse button down in the map area, we'll use a listener to indicate that a drag operation has started. Now, if the user moves the mouse, we'll use a listener to move the inner div along with the user's mouse movements to create the dragging effect. Finally, we'll use a listener to turn off the dragging operation when the mouse button is released. The following code demonstrates how we implemented the listeners:

File 29

```
// used to control moving the map div
var dragging = false;
var top;
var left;
var dragStartTop;
var dragStartLeft;

function init() {
    // make inner div big enough to display the map
    setInnerDivSize('2000px', '1400px');

    // wire up the mouse listeners to do dragging
    var outerDiv = document.getElementById("outerDiv");
    outerDiv.onmousedown = startMove;
    outerDiv.onmousemove = processMove;
    outerDiv.onmouseup = stopMove;

    // necessary to enable dragging on IE
    outerDiv.ondragstart = function() { return false; }
}

function startMove(event) {
    // necessary for IE
    if (!event) event = window.event;

    dragStartLeft = event.clientX;
    dragStartTop = event.clientY;
    var innerDiv = document.getElementById("innerDiv");
    innerDiv.style.cursor = "-moz-grab";

    top = stripPx(innerDiv.style.top);
    left = stripPx(innerDiv.style.left);

    dragging = true;
    return false;
}

function processMove(event) {
    if (!event) event = window.event;  // for IE
    var innerDiv = document.getElementById("innerDiv");
    if (dragging) {
        innerDiv.style.top = parseFloat(top) + (event.clientY - dragStartTop);
        innerDiv.style.left = parseFloat(left) + (event.clientX - dragStartLeft);
    }
}

function stopMove() {
    var innerDiv = document.getElementById("innerDiv");
    innerDiv.style.cursor = "";
    dragging = false;
}
```

```
function stripPx(value) {
    if (value == "") return 0;
    return parseFloat(value.substring(0, value.length - 2));
}
```

If you run the code at this point you'll now be able to drag that inner <*div*> around.

Step 5: Displaying the Map Tiles

The next step requires us to populate our inner div with the map tiles. Our approach to this will be fairly simple. The scrolling map effect is achieved by moving an inner div inside of an outer div; therefore, the tiles we need to display are calculated by determining the current position of the inner div relative to the outer div and then working out which tiles are visible in the portion of the inner div that are visible. We'll then add those tiles to the inner div.

It turns out implementing this behavior is not terribly difficult. We'll create a function checkTiles() to do all this, and call it from within the processMove() function. processMove() is called when the user drags the map, so by calling it from within, we'll be able to load our tiles as the map moves around. The following code excerpt shows how we've added these elements to our JavaScript code; for now, checkTiles() is just stubbed out with comments:

File 33

```
function processMove(event) {
    if (!event) event = window.event;  // for IE
    var innerDiv = document.getElementById("innerDiv");
    if (dragging) {
        innerDiv.style.top = parseFloat(top) + (event.clientY - dragStartTop);
        innerDiv.style.left = parseFloat(left) + (event.clientX - dragStartLeft);
    }
    checkTiles();
}
function checkTiles() {
    // check which tiles should be visible in the inner div
    // add each tile to the inner div, checking first to see
    // if it has already been added
}
```

Now, let's implement our stubbed-out checkTiles() function.

Calculating the Visible Tiles

Calculating the set of tiles that the user can see in the inner <*div*> is fairly straightforward. To understand how this works, it will help to

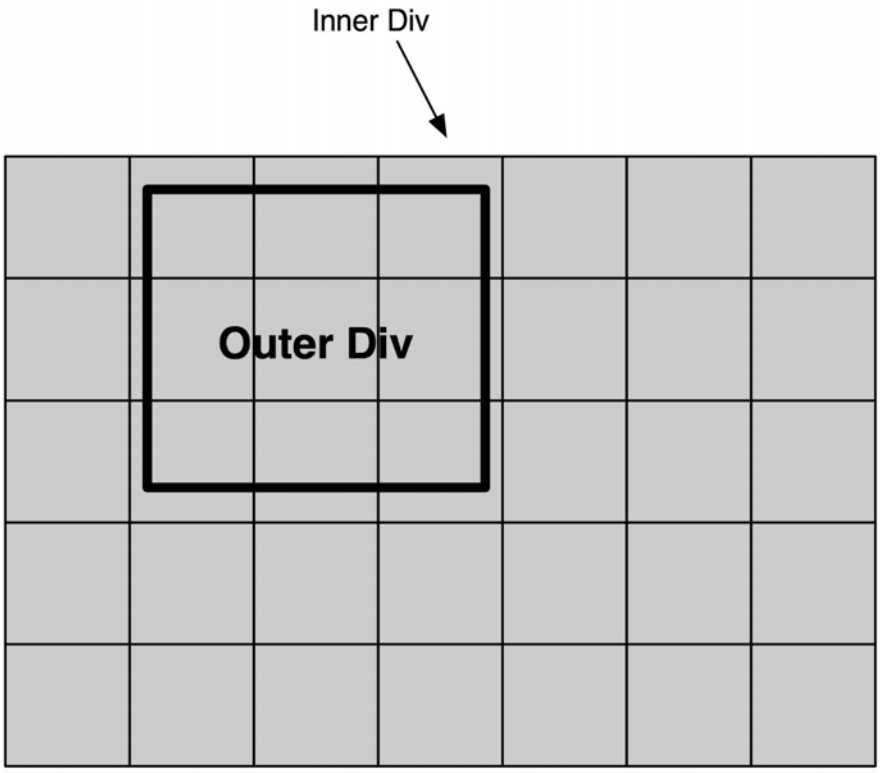

Figure 4.6: The Tile Grid

visualize the inner div as a grid where each grid cell is a placeholder of the tiles that we'll load. Figure 4.6 illustrates this concept.

Because we can't load *all* the tiles in the grid up-front, we'll need to calculate which of these grid cells are visible and load the tiles needed to fit into these cells. As Figure 4.6 shows, this is accomplished by calculating which grid cells are visible within the viewport created by the size of the outer div. In the figure, we see that nine cells are visible across three rows. Note that those cells that are only partially visible still count as being visible.

Let's see how to implement all this behavior we just described. To make things simple, we'll encapsulate all of the code to figure out which tiles are visible in a particular method, which we'll call getVisibleTiles(). The

first thing we need to figure out in getVisibleTiles()() is the position of the inner div relative to the outer div. This is fairly easy:

```
function getVisibleTiles() {
    var innerDiv = document.getElementById("innerDiv");
    var mapX = stripPx(innerDiv.style.left);
    var mapY = stripPx(innerDiv.style.top);
}
```

The stripPx() function, shown earlier, converts the string value returned by innerDiv.style.left (such as "100px") to a numeric value (say, 100). Now, we can divide these positions by the size of the tiles to work out the starting row and column of the tiles. This is just two lines of code:

```
var startX = Math.abs(Math.floor(mapX / tileSize)) - 1;
var startY = Math.abs(Math.floor(mapY / tileSize)) - 1;
```

Note that we haven't yet defined the tileSize variable; we'll do that globally (at the top of our JavaScript code) and you'll see it when we show the entire page in just a few paragraphs. (Or, you can see it now by visiting http://www.ajaxian.com/pragajax/code/amaps/XXX.html). The call to Math.floor() will round the quotient to an integer, discarding the remainder (so 1.4 will be rounded down to 1). This will cause partial tiles to be displayed. Math.abs() converts negative values to a positive number, which in our case is necessary as the inner div position will nearly always be negative to the outer div, whereas our tile columns/rows are always positive numbers. Finally, we substract one from the result to make our map load the tiles a touch early for smoother effect.

The final bit of calculation is to determine the number of rows and columns that are visible in the viewport:

```
var tilesX = Math.ceil(viewportWidth / tileSize) + 1;
var tilesY = Math.ceil(viewportHeight / tileSize) + 1;
```

As with tileSize(), we'll declare both viewportWidth and viewportHeight as global variables and show that in just a bit. We use Math.ceil(), the opposite of Math.floor() (so it rounds the quotient up regardless of size of remainder), to ensure that if any portion of a column or row is visible, we'll display it. And, just as we substracted one from the index of the tiles in the previous lines, we'll add one to the number of columns and rows to make the scroll effect smooth.

We now have all the data we need to calculate all of the visible tiles in the viewport, plus as we've discussed, a few around the edges that aren't immediately visible but will be shortly. Now we'll build an array

that contains all of the tiles that need to be loaded. To build this array, we'll write two for loops, one nested inside the other, that each perform an iteration for each column and row that is currently visible. Inside each loop iteration, we'll add the column and row number of each tile to display:

```
var visibleTileArray = [];
var counter = 0;
for (x = startX; x < (tilesX + startX); x++) {
    for (y = startY; y < (tilesY + startY); y++) {
        visibleTileArray[counter++] = [x, y];
    }
}
return visibleTileArray;
```

Note that we're actually creating a two dimensional array; the value of each item in our array is another array. We did this because we need to pass back two values: the column and row index. And now, we're done calculating the tiles that are visible in the inner div, and we can move on and work on the code to actually display them. But first, let's review all of the code we've written so far:

File 30

```
function checkTiles() {
    // check which tiles should be visible in the inner div
    var visibleTiles = getVisibleTiles();
    // add each tile to the inner div, checking first to see
    // if it has already been added
}
function getVisibleTiles() {
    var innerDiv = document.getElementById("innerDiv");
    var mapX = stripPx(innerDiv.style.left);
    var mapY = stripPx(innerDiv.style.top);
    var startX = Math.abs(Math.floor(mapX / tileSize)) - 1;
    var startY = Math.abs(Math.floor(mapY / tileSize)) - 1;
    var tilesX = Math.ceil(viewportWidth / tileSize) + 1;
    var tilesY = Math.ceil(viewportHeight / tileSize) + 1;
    var visibleTileArray = [];
    var counter = 0;
    for (x = startX; x < (tilesX + startX); x++) {
        for (y = startY; y < (tilesY + startY); y++) {
            visibleTileArray[counter++] = [x, y];
        }
    }
    return visibleTileArray;
}
```

Displaying the Visible Tiles

We've now coded half of the checkTiles() function, which as you may recall is the function responsible for both calculating the visible tiles

and displaying them. Now, let's implement the other half of that function: displaying the tiles.

All we need to do here is iterate through each element of the array of visible tiles we returned from the getVisibleTiles() function, and for each array element, add a tile image to the inner div. Here's the new code for our checkTiles() function:

File 31

```
Line 1  function checkTiles() {
        // check which tiles should be visible in the inner div
        var visibleTiles = getVisibleTiles();

5       // add each tile to the inner div, checking first to see
        // if it has already been added
        var innerDiv = document.getElementById("innerDiv");
        var visibleTilesMap = {};
        for (i = 0; i < visibleTiles.length; i++) {
10          var tileArray = visibleTiles[i];
            var tileName = "x" + tileArray[0] + "y" + tileArray[1] + "z0";
            visibleTilesMap[tileName] = true;
            var img = document.getElementById(tileName);
            if (!img) {
15              img = document.createElement("img");
                img.src = "resources/tiles/" + tileName + ".jpg";
                img.style.position = "absolute";
                img.style.left = (tileArray[0] * tileSize) + "px";
                img.style.top = (tileArray[1] * tileSize) + "px";
20              img.setAttribute("id", tileName);
                innerDiv.appendChild(img);
            }
        }
    }
```

We start out on line 8 by creating a empty map (map in the JavaScript sense; a hash that contains key to value mappings). We're going to add an entry to this map for each visible image; we'll discuss why we're doing this a little later.

On line 9, we start looping through each element in the array we sent back from getVisibleTiles(). For each element, we build the name of the image file that will be loaded in. (If you recall, the file naming convention we choose in Step 2 was x0y0z0, where the numbers are replaced with the index of the tile in the tile grid.) We also use this name as the key in the visibleTilesMap variable, and on lines 13 and 20 you can see that we also use it as the id attribute for each img element that we add to the inner div. This is so on lines 13 and 14, we can check to see if we've already added a given tile to the inner div, and if we have, avoid adding it again.

Finally, in line 15 through line 21, we create the <*img*> element and add it to the inner div. Note that on line 16 we have to specify the URL

of the image tile. If you have Java installed and executed the code from Steps 1 and 2 to create your own image tiles, great! Reference them on line 16, setting the URI to wherever you put them. If not, you can reference our tiles on-line at http://www.ajaxian.com/pragajax/code/amaps/tiles/x0y0z0.jp where x0y0z0 should be replaced with the tile you want to load.

You can now view this webpage in your browser, and enjoy a scrolling map of Spain! We've placed a copy on-line at http://www.ajaxian.com/pragajax/code/amap Here's all the code we've written so far:

File 31

```
<html>
    <head>
        <title>Ajaxian Maps</title>
        <style type="text/css">
            h1 {
                font: 20pt sans-serif;
            }
            #outerDiv {
                height: 600px;
                width: 800px;
                border: 1px solid black;
                position: relative;
                overflow: hidden;
            }
            #innerDiv {
                position: relative;
                left: 0px;
                top: 0px;
            }
        </style>
        <script type="text/javascript">
            // constants
            var viewportWidth = 800;
            var viewportHeight = 600;
            var tileSize = 100;

            // used to control moving the map div
            var dragging = false;
            var top;
            var left;
            var dragStartTop;
            var dragStartLeft;

            function init() {
                // make inner div big enough to display the map
                setInnerDivSize('2000px', '1400px');

                // wire up the mouse listeners to do dragging
                var outerDiv = document.getElementById("outerDiv");
                outerDiv.onmousedown = startMove;
                outerDiv.onmousemove = processMove;
                outerDiv.onmouseup = stopMove;

                // necessary to enable dragging on IE
                outerDiv.ondragstart = function() { return false; }

                checkTiles();
            }

            function startMove(event) {
                // necessary for IE
```

```
    if (!event) event = window.event;
    dragStartLeft = event.clientX;
    dragStartTop = event.clientY;
    var innerDiv = document.getElementById("innerDiv");
    innerDiv.style.cursor = "-moz-grab";
    top = stripPx(innerDiv.style.top);
    left = stripPx(innerDiv.style.left);
    dragging = true;
    return false;
}
function processMove(event) {
    if (!event) event = window.event;  // for IE
    var innerDiv = document.getElementById("innerDiv");
    if (dragging) {
        innerDiv.style.top = parseFloat(top) + (event.clientY - dragStartTop);
        innerDiv.style.left = parseFloat(left) + (event.clientX - dragStartLeft);
    }
    checkTiles();
}
function checkTiles() {
    // check which tiles should be visible in the inner div
    var visibleTiles = getVisibleTiles();
    // add each tile to the inner div, checking first to see
    // if it has already been added
    var innerDiv = document.getElementById("innerDiv");
    var visibleTilesMap = {};
    for (i = 0; i < visibleTiles.length; i++) {
        var tileArray = visibleTiles[i];
        var tileName = "x" + tileArray[0] + "y" + tileArray[1] + "z0";
        visibleTilesMap[tileName] = true;
        var img = document.getElementById(tileName);
        if (!img) {
            img = document.createElement("img");
            img.src = "resources/tiles/" + tileName + ".jpg";
            img.style.position = "absolute";
            img.style.left = (tileArray[0] * tileSize) + "px";
            img.style.top = (tileArray[1] * tileSize) + "px";
            img.setAttribute("id", tileName);
            innerDiv.appendChild(img);
        }
    }
}
function getVisibleTiles() {
    var innerDiv = document.getElementById("innerDiv");
    var mapX = stripPx(innerDiv.style.left);
    var mapY = stripPx(innerDiv.style.top);
    var startX = Math.abs(Math.floor(mapX / tileSize)) - 1;
    var startY = Math.abs(Math.floor(mapY / tileSize)) - 1;
    var tilesX = Math.ceil(viewportWidth / tileSize) + 1;
    var tilesY = Math.ceil(viewportHeight / tileSize) + 1;
    var visibleTileArray = [];
    var counter = 0;
    for (x = startX; x < (tilesX + startX); x++) {
        for (y = startY; y < (tilesY + startY); y++) {
            visibleTileArray[counter++] = [x, y];
        }
```

```
                }
                return visibleTileArray;
            }
            function stopMove() {
                var innerDiv = document.getElementById("innerDiv");
                innerDiv.style.cursor = "";
                dragging = false;
            }
            function stripPx(value) {
                if (value == "") return 0;
                return parseFloat(value.substring(0, value.length - 2));
            }
            function setInnerDivSize(width, height) {
                var innerDiv = document.getElementById("innerDiv");
                innerDiv.style.width = width;
                innerDiv.style.height = height;
            }
        </script>
    </head>
    <body onload="init()">
        <p>
            <h1>Ajaxian Maps</h1>
        </p>
        <div id="outerDiv">
            <div id="innerDiv">
                The rain in Spain falls mainly in the plains.
            </div>
        </div>
    </body>
</html>
```

Cleaning Up Unused Tiles

We've got some neat scrolling, but there's one glaring inefficiency. We add tiles to the inner div on demand, but we never remove the tiles that are no longer visible. Fortunately, we've already done some of the work to accomodate this feature. If you recall, we created a JavaScript map named visibleTilesMap in the checkTiles() function but never did anything with it. Now, we're going to.

After we add the image tiles to the inner div, we'll select all of the img elements that are present in the inner div, and for each img element, we'll check to see if its id attribute is present in the visibleTilesMap variable. If so, we know that its a currently visible tile and should be left in the inner div. If not, the img is no longer visible and can be removed. Here's the additional code in checkTiles() to implement this functionality:

File 32

```
function checkTiles() {
    // check which tiles should be visible in the inner div
    var visibleTiles = getVisibleTiles();
```

```
    // add each tile to the inner div, checking first to see
    // if it has already been added
    var innerDiv = document.getElementById("innerDiv");
    var visibleTilesMap = {};
    for (i = 0; i < visibleTiles.length; i++) {
        var tileArray = visibleTiles[i];
        var tileName = "x" + tileArray[0] + "y" + tileArray[1] + "z0";
        visibleTilesMap[tileName] = true;
        var img = document.getElementById(tileName);
        if (!img) {
            img = document.createElement("img");
            img.src = "resources/tiles/" + tileName + ".jpg";
            img.style.position = "absolute";
            img.style.left = (tileArray[0] * tileSize) + "px";
            img.style.top = (tileArray[1] * tileSize) + "px";
            img.setAttribute("id", tileName);
            innerDiv.appendChild(img);
        }
    }
    var imgs = innerDiv.getElementsByTagName("img");
    for (i = 0; i < imgs.length; i++) {
        var id = imgs[i].getAttribute("id");
        if (!visibleTilesMap[id]) {
            innerDiv.removeChild(imgs[i]);
            i--;  // compensate for live nodelist
        }
    }
}
```

Ah, much better. Figure 4.7, on the next page shows what this should look like.

Step 6: Zooming

Zooming is wicked easy; in fact, the hardest bit is just getting a zoom widget to appear floating above the map. First, we need to create some kind of image that the user can click on to allow the user to zoom. In Google Maps, it's a slider; for us, we'll just create a simple image that toggles between our two zoom levels. You can use any image you like; we've created a simple one that's available at http://www.ajaxian.com/pragajax/code/amap

To float the image above the map, we have to properly set the z-index of our inner div. Browsers support layering elements on top of each other; the z-index CSS property is used to determine how the layering occurs. The lower the value, the lower in the layer the element will appear. Because we want to put our zoom widget above the tile images, we'll need to set the z-index of the inner div to 0.

Now, let's add the zoom widget. We'll enclose it in a div and place it inside the outer div, as a peer of the inner div, and set the z-index properties appropriately:

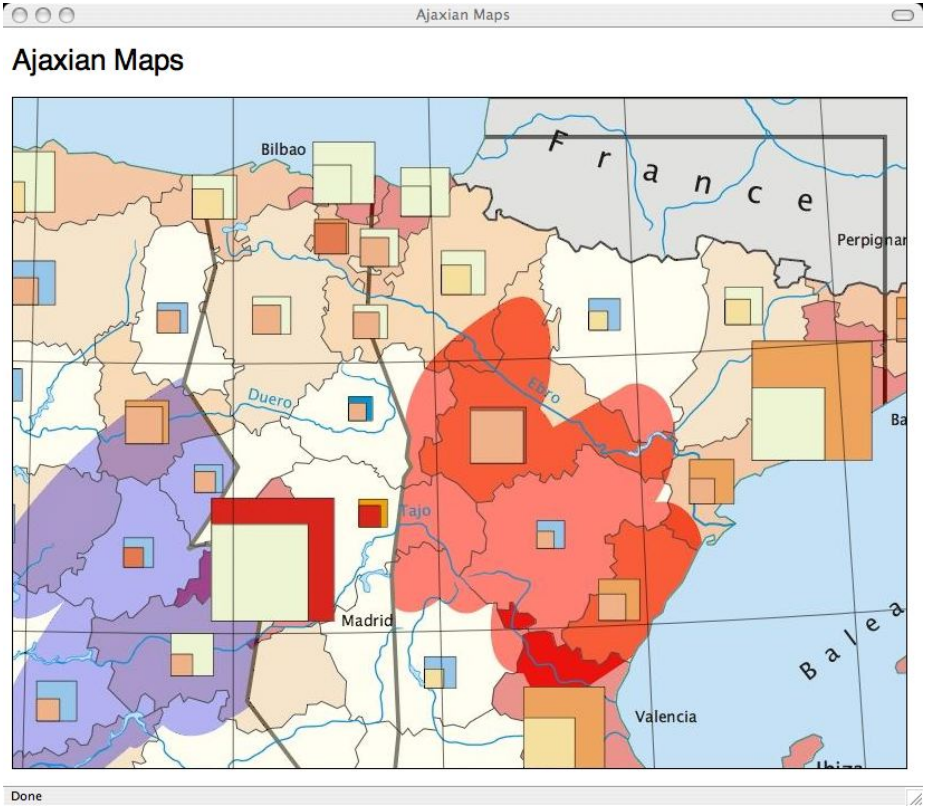

Figure 4.7: Ajaxian Maps!

File 34

```
<body onload="init()">
    <p>
        <h1>Ajaxian Maps</h1>
    </p>
    <div id="outerDiv">
        <div style="position: absolute; top: 10px; left: 10px; z-index: 1">
            <img src="resources/images/zoom.png"
            onclick="toggleZoom()"/>
            <!-- <label id="step6.toggle.zoom"/> -->
        </div>
        <div id="innerDiv" style="z-index: 0">
            The rain in Spain falls mainly in the plains.
        </div>
    </div>
</body>
```

That will give us our floating zoom widget; now we need to create the toggleZoom() function that we referenced on line . This will require a

Figure 4.8: The Google Maps Zoom Widget

few minor changes to our code. First, we need to create some sort of global state that tracks the current zoom level of our map. Second, we need to reference this state in the various relevant places in our code (just one, actually).

Let's start with the global state. We'll create a variable zoom to track the current zoom level, and while we're at it, add a constant (in the form of a two-dimensional array) for declaring the two different sizes of the inner div:

File 34
```
var zoom = 0;
var zoomSizes = [ [ "2000px", "1400px" ], [ "1500px", "1050px" ] ];
```

Now, in the name of cleanliness, we'll change the first line of our init method from this:

File 32
```
setInnerDivSize('2000px', '1400px');
```

to this:

File 34
```
setInnerDivSize(zoomSizes[zoom][0], zoomSizes[zoom][1]);
```

There's just one other place we need to wire in the zoom support: our checkTiles() function, which creates the img elements for the tiles and gives them their URL. We need to change this hard-coded zoom level code:

File 32
```
var tileName = "x" + tileArray[0] + "y" + tileArray[1] + "z0";
```

to this:

File 34
```
var tileName = "x" + tileArray[0] + "y" + tileArray[1] + "z" + zoom;
```

All that remains is implementing the toggleZoom() function, which we've done here:

File 34
```
function toggleZoom() {
    zoom = (zoom == 0) ? 1 : 0;

    var innerDiv = document.getElementById("innerDiv");
    var imgs = innerDiv.getElementsByTagName("img");
    while (imgs.length > 0) innerDiv.removeChild(imgs[0]);

    setInnerDivSize(zoomSizes[zoom][0], zoomSizes[zoom][1]);

    checkTiles();
}
```

Nothing too tricky; we swap the value of the zoom variable between 0 and 1, delete all the <*img*> elements from the inner div, change the size of the inner div based on the zoom level, and finally, we invoke checkTiles() to rebuild the map with the new zoom level's tiles.

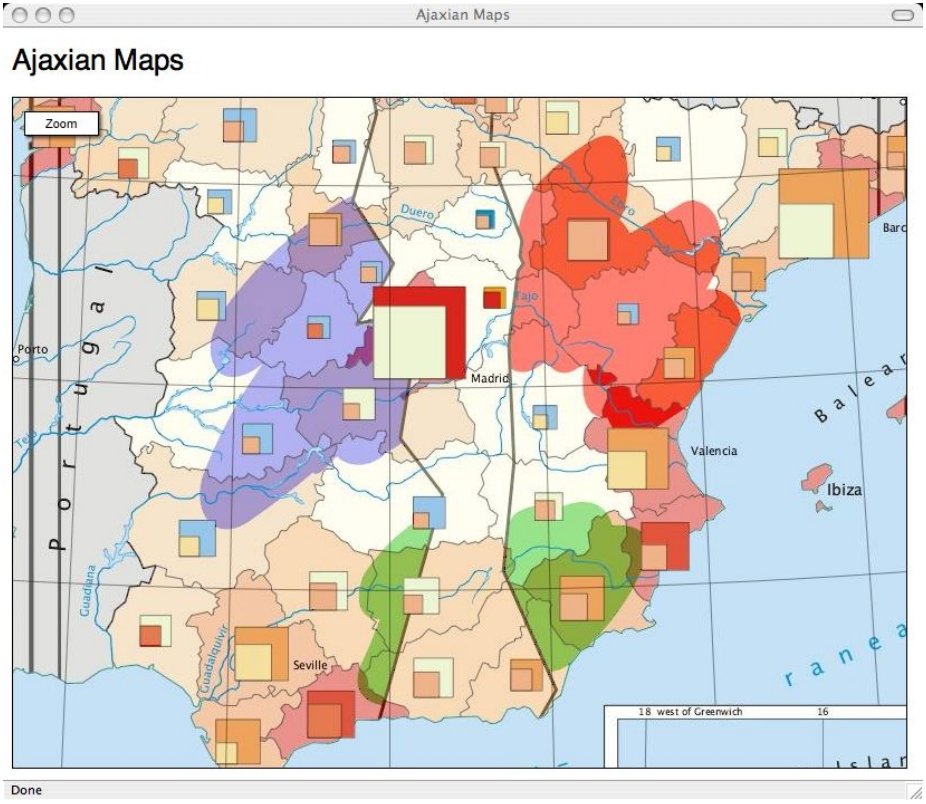

Figure 4.9: Ajaxian Maps Zoomed Out

And now, we have zooming in our map application! Cool. Figure 4.9 shows the zoom feature in action, with our map zoomed to the smaller size.

Step 7: Push Pins and Dialogs

The final feature: adding push pins with alpha transparency that when clicked show a dialog that also has alpha transparency. The hardest part here is actually creating the images. We've created two images to serve these purposes, and they're available at http://www.ajaxian.com/pragajax/code/amap and http://www.ajaxian.com/pragajax/code/amaps/images/dialog.png, respectively.

We're not going to implement a server back-end that does searching, etc., so just as with zooming we implemented a toggle, we'll implement

a toggle for our push pin. The graphic for the toggle is available at http://www.ajaxian.com/pragajax/code/amaps/images/pushpintoggle.png.

We'll place the push pin toggle in right next to the zoom toggle by adding a new div for it:

File 36
```
<body onload="init()">
    <p>
        <h1>Ajaxian Maps</h1>
    </p>
    <div id="outerDiv">
        <div style="position: absolute; top: 10px; left: 10px; z-index: 1">
            <img src="resources/images/zoom.png" onclick="toggleZoom()"/>
        </div>
        <div style="position: absolute; top: 10px; left: 87px; z-index: 1">
            <img src="resources/images/pushpin.png" onclick="togglePushPin()"/>
        </div>
        <div id="innerDiv" style="z-index: 0">
            The rain in Spain falls mainly in the plains.
        </div>
    </div>
</body>
```

Now we need to implement togglePushPin(), which, frankly, is a piece of cake. We'll just add an absolutely positioned image with a z-index of 1 to the inner div, add an onclick handler to it, and wire that handler to display the dialog at an absolute position just above the push pin:

Missing: what code should this reference?

File 36
```
function togglePushPin() {
    var pinImage = document.getElementById("pushPin");
    if (pinImage) {
        pinImage.parentNode.removeChild(pinImage);
        var dialog = document.getElementById("pinDialog");
        dialog.parentNode.removeChild(dialog);
        return;
    }
    var innerDiv = document.getElementById("innerDiv");
    pinImage = document.createElement("img");
    pinImage.src = "resources/images/pin.png";
    pinImage.style.position = "absolute";
    pinImage.style.left = (zoom == 0) ? "850px" : "630px";
    pinImage.style.top = (zoom == 0) ? "570px" : "420px";
    pinImage.style.zIndex = 1;
    pinImage.setAttribute("id", "pushPin");
    innerDiv.appendChild(pinImage);
    var dialog = document.createElement("div");
    dialog.style.position = "absolute";
    dialog.style.left = (stripPx(pinImage.style.left) - 90) + "px";
    dialog.style.top = (stripPx(pinImage.style.top) - 210) + "px";
    dialog.style.width = "309px";
    dialog.style.height = "229px";
    dialog.style.backgroundImage = "url(resources/images/dialog.png)";
    dialog.style.zIndex = 2;
    dialog.setAttribute("id", "pinDialog");
    dialog.innerHTML = "<table height='80%' width='100%'>" +
        "<tr><td align='center'>The capital of Spain</td></tr></table>";
```

```
    innerDiv.appendChild(dialog);
}
```

There's just one little problem with this new behavior. Do you remember the image remover code in checkTiles()? It removes any img element child of the inner div that has been explicitly added in that function. Of course, it will clobber our push pin as well, since it is an img child of the inner div, so we need to modify the function to ignore the push pin:

File 36

```
var imgs = innerDiv.getElementsByTagName("img");
for (i = 0; i < imgs.length; i++) {
    var id = imgs[i].getAttribute("id");
    if (!visibleTilesMap[id]) {
        if (id != "pushPin") {
            innerDiv.removeChild(imgs[i]);
            i--;  // compensate for live nodelist
        }
    }
}
```

We're done! We've implemented all of the features we discussed in the introduction of this chapter. Let's wrap up by... err, wait a second. While Firefox, Safari, and other browsers provide native support for PNGs with alpha transparency, IE 6 does not. If you've been using that browser to try this sample code, the zoom and push pin buttons as well as the push pin and dialog itself have looked really awful.

Fortunately, there's an easy (but annoying) fix. Despite not supporting PNGs out of the box, IE can use some (IE-specific) JavaScript magic to parse out the alpha channel from a PNG at run-time and display it correctly. There are a number of websites which document this workaround; in order to avoid sidetracking our Google Maps story, we'll just use a JavaScript library provided by one of these websites, www.alistapart.com,[1] to solve our problem.

First, we need to include these new JavaScripts in our webpage, which we'll do at the top:

File 35

```
<script language="javascript"
        src="resources/js/browserdetect_lite.js"
        type="text/javascript">
</script>
<script language="javascript"
        src="resources/js/opacity.js"
        type="text/javascript">
</script>
```

[1] http://www.alistapart.com/articles/pngopacity

Then, because this library requires that the PNGs it fixes be background images in a div, we need to change our push pin from an img element to a div, as well as our two toggle buttons, and then finally use this library to fix all of these divs. We'll change the toggle button images to div background images first:

File 35
```
<body onload="init()">
    <p>
        <h1>Ajaxian Maps</h1>
    </p>
    <div id="outerDiv">
        <div id="toggleZoomDiv" onclick="toggleZoom()">
        </div>
        <div id="togglePushPinDiv" onclick="togglePushPin()">
        </div>
        <div id="innerDiv" style="z-index: 0">
            The rain in Spain falls mainly in the plains.
        </div>
    </div>
</body>
```

As part of this change, we moved the style attribute settings on the toggle divs into the style sheet we defined at the top of the file (something we probably should have done anyway):

File 35
```
#toggleZoomDiv {
    position: absolute;
    top: 10px;
    left: 10px;
    z-index: 1;
    width: 72px;
    height: 30px;
}
#togglePushPinDiv {
    position: absolute;
    top: 10px;
    left: 87px;
    z-index: 1;
    width: 72px;
    height: 30px;
}
```

We now need to add two lines to our init() method to use our new IE transparency library with the toggle divs:

File 35
```
// fix the toggle divs to be transparent in IE
new OpacityObject('toggleZoomDiv','resources/images/zoom').setBackground();
new OpacityObject('togglePushPinDiv','resources/images/pushpin').setBackground();
```

And finally, we need to reformat the togglePushPin() function to use this new technique:

File 35
```
function togglePushPin() {
    var pinImage = document.getElementById("pushPin");
    if (pinImage) {
```

```
            pinImage.parentNode.removeChild(pinImage);
            var dialog = document.getElementById("pinDialog");
            dialog.parentNode.removeChild(dialog);
            return;
        }
        var innerDiv = document.getElementById("innerDiv");
        pinImage = document.createElement("div");
        pinImage.style.position = "absolute";
        pinImage.style.left = (zoom == 0) ? "850px" : "630px";
        pinImage.style.top = (zoom == 0) ? "570px" : "420px";
        pinImage.style.width = "37px";
        pinImage.style.height = "34px";
        pinImage.style.zIndex = 1;
        pinImage.setAttribute("id", "pushPin");
        innerDiv.appendChild(pinImage);
        new OpacityObject('pushPin','resources/images/pin').setBackground();
        var dialog = document.createElement("div");
        dialog.style.position = "absolute";
        dialog.style.left = (stripPx(pinImage.style.left) - 90) + "px";
        dialog.style.top = (stripPx(pinImage.style.top) - 210) + "px";
        dialog.style.width = "309px";
        dialog.style.height = "229px";
        dialog.style.zIndex = 2;
        dialog.setAttribute("id", "pinDialog");
        dialog.innerHTML = "<table height='80%' width='100%'>" +
            "<tr><td align='center'>The capital of Spain</td></tr></table>";
        innerDiv.appendChild(dialog);
        new OpacityObject('pinDialog','resources/images/dialog').setBackground();
}
```

And now, finally, we are done. Up until the image transparency bit, our code was really quite clean and had very little in the way of "cross-browser" hacks. Now, unfortunately, it's had to undergo a bit of an IE makeover, but the consolation prize is that IE 7 natively supports PNG so all of this may someday be unnecessary.

For review, let's take a look at our entire page:

File 35

```
<html>
    <head>
        <title>Ajaxian Maps</title>
        <style type="text/css">
            h1 {
                font: 20pt sans-serif;
            }
            #outerDiv {
                height: 600px;
                width: 800px;
                border: 1px solid black;
                position: relative;
                overflow: hidden;
            }
            #innerDiv {
                position: relative;
                left: 0px;
                top: 0px;
```

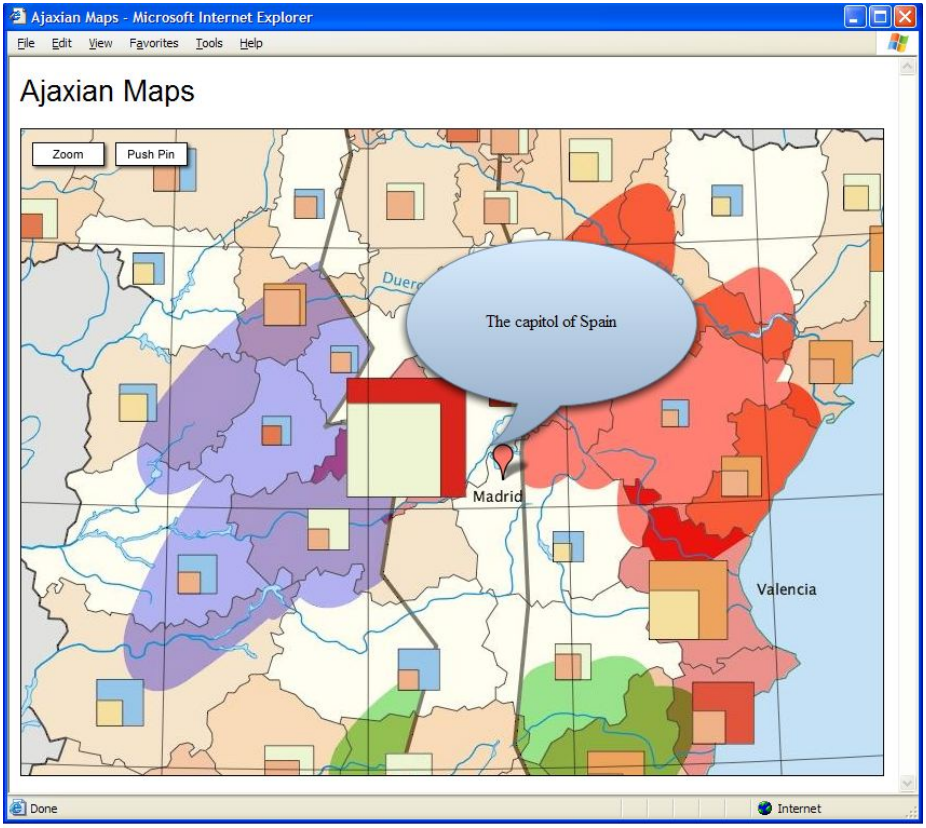

Figure 4.10: Ajaxian Maps Push Pin and Dialog on IE 6

```
    }
    #toggleZoomDiv {
        position: absolute;
        top: 10px;
        left: 10px;
        z-index: 1;
        width: 72px;
        height: 30px;
    }
    #togglePushPinDiv {
        position: absolute;
        top: 10px;
        left: 87px;
        z-index: 1;
        width: 72px;
        height: 30px;
    }
</style>
<script language="javascript"
```

```
        src="resources/js/browserdetect_lite.js"
        type="text/javascript">
</script>
<script language="javascript"
        src="resources/js/opacity.js"
        type="text/javascript">
</script>
<script type="text/javascript">
    // constants
    var viewportWidth = 800;
    var viewportHeight = 600;
    var tileSize = 100;
    var zoom = 0;
    var zoomSizes = [ [ "2000px", "1400px" ], [ "1500px", "1050px" ] ];

    // used to control moving the map div
    var dragging = false;
    var top;
    var left;
    var dragStartTop;
    var dragStartLeft;

    function init() {
        // make inner div big enough to display the map
        setInnerDivSize(zoomSizes[zoom][0], zoomSizes[zoom][1]);

        // wire up the mouse listeners to do dragging
        var outerDiv = document.getElementById("outerDiv");
        outerDiv.onmousedown = startMove;
        outerDiv.onmousemove = processMove;
        outerDiv.onmouseup = stopMove;

        // necessary to enable dragging on IE
        outerDiv.ondragstart = function() { return false; }

        // fix the toggle divs to be transparent in IE
        new OpacityObject('toggleZoomDiv','resources/images/zoom').setBackground();
        new OpacityObject('togglePushPinDiv','resources/images/pushpin').setBackground();

        checkTiles();
    }
    function startMove(event) {
        // necessary for IE
        if (!event) event = window.event;

        dragStartLeft = event.clientX;
        dragStartTop = event.clientY;
        var innerDiv = document.getElementById("innerDiv");
        innerDiv.style.cursor = "-moz-grab";

        top = stripPx(innerDiv.style.top);
        left = stripPx(innerDiv.style.left);

        dragging = true;
        return false;
    }
    function processMove(event) {
        if (!event) event = window.event;  // for IE
        var innerDiv = document.getElementById("innerDiv");
        if (dragging) {
            innerDiv.style.top = parseFloat(top) + (event.clientY - dragStartTop);
            innerDiv.style.left = parseFloat(left) + (event.clientX - dragStartLeft);
        }
        checkTiles();
    }
```

```
function checkTiles() {
    // check which tiles should be visible in the inner div
    var visibleTiles = getVisibleTiles();

    // add each tile to the inner div, checking first to see
    // if it has already been added
    var innerDiv = document.getElementById("innerDiv");
    var visibleTilesMap = {};
    for (i = 0; i < visibleTiles.length; i++) {
        var tileArray = visibleTiles[i];
        var tileName = "x" + tileArray[0] + "y" + tileArray[1] + "z" + zoom;
        visibleTilesMap[tileName] = true;
        var img = document.getElementById(tileName);
        if (!img) {
            img = document.createElement("img");
            img.src = "resources/tiles/" + tileName + ".jpg";
            img.style.position = "absolute";
            img.style.left = (tileArray[0] * tileSize) + "px";
            img.style.top = (tileArray[1] * tileSize) + "px";
            img.style.zIndex = 0;
            img.setAttribute("id", tileName);
            innerDiv.appendChild(img);
        }
    }

    var imgs = innerDiv.getElementsByTagName("img");
    for (i = 0; i < imgs.length; i++) {
        var id = imgs[i].getAttribute("id");
        if (!visibleTilesMap[id]) {
            innerDiv.removeChild(imgs[i]);
            i--;  // compensate for live nodelist
        }
    }
}
function getVisibleTiles() {
    var innerDiv = document.getElementById("innerDiv");

    var mapX = stripPx(innerDiv.style.left);
    var mapY = stripPx(innerDiv.style.top);

    var startX = Math.abs(Math.floor(mapX / tileSize)) - 1;
    var startY = Math.abs(Math.floor(mapY / tileSize)) - 1;

    var tilesX = Math.ceil(viewportWidth / tileSize) + 1;
    var tilesY = Math.ceil(viewportHeight / tileSize) + 1;

    var visibleTileArray = [];
    var counter = 0;
    for (x = startX; x < (tilesX + startX); x++) {
        for (y = startY; y < (tilesY + startY); y++) {
            visibleTileArray[counter++] = [x, y];
        }
    }
    return visibleTileArray;
}

function stopMove() {
    var innerDiv = document.getElementById("innerDiv");
    innerDiv.style.cursor = "";
    dragging = false;
}
function stripPx(value) {
    if (value == "") return 0;
```

```
            return parseFloat(value.substring(0, value.length - 2));
        }
        function setInnerDivSize(width, height) {
            var innerDiv = document.getElementById("innerDiv");
            innerDiv.style.width = width;
            innerDiv.style.height = height;
        }
        function toggleZoom() {
            zoom = (zoom == 0) ? 1 : 0;
            var innerDiv = document.getElementById("innerDiv");
            var imgs = innerDiv.getElementsByTagName("img");
            while (imgs.length > 0) innerDiv.removeChild(imgs[0]);
            setInnerDivSize(zoomSizes[zoom][0], zoomSizes[zoom][1]);
            if (document.getElementById("pushPin")) togglePushPin();
            checkTiles();
        }
        function togglePushPin() {
            var pinImage = document.getElementById("pushPin");
            if (pinImage) {
                pinImage.parentNode.removeChild(pinImage);
                var dialog = document.getElementById("pinDialog");
                dialog.parentNode.removeChild(dialog);
                return;
            }
            var innerDiv = document.getElementById("innerDiv");
            pinImage = document.createElement("div");
            pinImage.style.position = "absolute";
            pinImage.style.left = (zoom == 0) ? "850px" : "630px";
            pinImage.style.top = (zoom == 0) ? "570px" : "420px";
            pinImage.style.width = "37px";
            pinImage.style.height = "34px";
            pinImage.style.zIndex = 1;
            pinImage.setAttribute("id", "pushPin");
            innerDiv.appendChild(pinImage);
            new OpacityObject('pushPin','resources/images/pin').setBackground();
            var dialog = document.createElement("div");
            dialog.style.position = "absolute";
            dialog.style.left = (stripPx(pinImage.style.left) - 90) + "px";
            dialog.style.top = (stripPx(pinImage.style.top) - 210) + "px";
            dialog.style.width = "309px";
            dialog.style.height = "229px";
            dialog.style.zIndex = 2;
            dialog.setAttribute("id", "pinDialog");
            dialog.innerHTML = "<table height='80%' width='100%'>" +
                "<tr><td align='center'>The capital of Spain</td></tr></table>";
            innerDiv.appendChild(dialog);
            new OpacityObject('pinDialog','resources/images/dialog').setBackground();
        }
    </script>
</head>
<body onload="init()">
    <p>
        <h1>Ajaxian Maps</h1>
    </p>
    <div id="outerDiv">
        <div id="toggleZoomDiv" onclick="toggleZoom()">
        </div>
```

```
            <div id="togglePushPinDiv" onclick="togglePushPin()">
            </div>
            <div id="innerDiv" style="z-index: 0">
                The rain in Spain falls mainly in the plains.
            </div>
        </div>
    </body>
</html>
```

4.4 Conclusion

The Ajaxian Maps code we showed you in this chapter is little changed from our initial, seat-of-the-pants version coded in two hours. We spent another two hours polishing things up, fixing a few bugs, and introducing compatibility for Internet Explorer 6.0 (which required two minor changes that we commented in the source code as well as the transparency issues we just finished discussing).

Imagine how far you could take this code if you had two or three full-time developers working on it for a few months! Certainly, all of the remaining interface features in Google Maps would be easily accomodated in that time period.

Feel free to use the code from this chapter to implement your own Google Maps interface for your own projects, which can ultimately be generalized to a solution for any time you need to display a larger image that you could possibly fit into memory, and enable annotations to appear on top of that image.

And the next time someone tells you Ajax is hard? Tell them you know better.

Chapter 5

Ajax Frameworks

Up until now, we've looked at Ajax either at an abstract architectural level, or from down in the tunnels underneath the structure. The DOM API and JavaScript's sometimes tortured interactions with it form the basis of all other Ajaxian techniques. Though it is vital to understand these things for when you run into trouble, it is also likely that you've been left scratching your head from time to time. Maybe you wondered who decided to use magic numbers for all the readyState() values. Or why the industry standard way to create an XHR instance is in a try/catch block that will encounter an exception ~70% of the time. In fact, if you are anything like us, it probably occurred to you that you could write a fairly simple wrapper around this stuff to make it more usable in production code. These wrappers are fairly common; the internet is littered with their corpses.

A few library wrappers have survived and flourished to become full-fledged toolkits. They provide us with much better leverage for using these Ajaxian techniques to make real applications. In this chapter, we will take a look at several of these frameworks at our disposal, and will rewrite Hector's CRM application using the most mature and popular versions.

5.1 Frameworks, Toolkits, and Libraries

As Ajax has taken off, we have been inundated with projects claiming to have Ajax support. Since the term itself has such a broad meaning in the popular consciousness, though, it is often hard to know exactly what this means. Does the site perform asynchronous callbacks to the

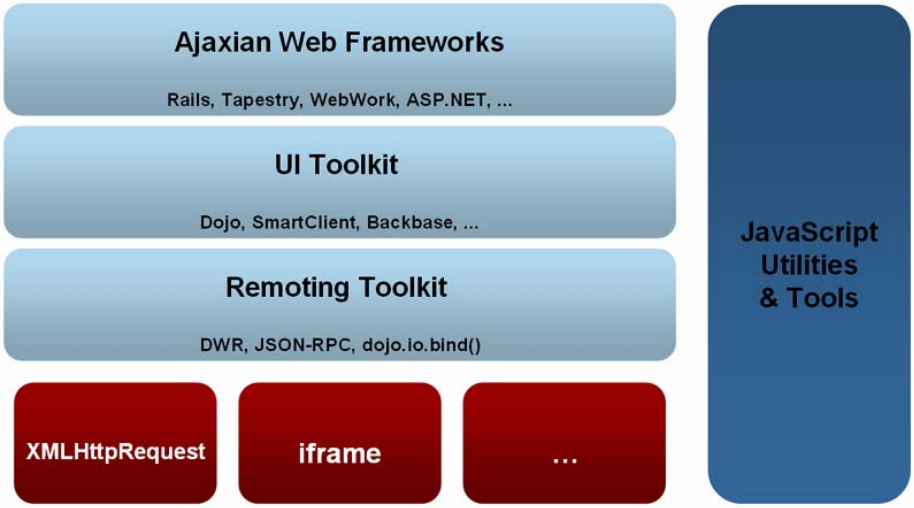

Figure 5.1: Layers of Ajax Frameworks

server? Does it re-render fresh data in-page? Or does it just manipulate the properties of existing DOM nodes?

Figure 5.1 clarifies the distinct layers of Ajax proper.

Remoting Toolkit

The lowest level of Ajax helpers is a remoting toolkit. If you were to create your own toolkit, this would probably be where you started out: wrapping XMLHttpRequest with your own API to make life easier. A really good remoting toolkit should be able to do much more than simply hide our ugly try/catch XHR instantiation code. What should happen if your Ajaxian page is loaded by a browser that does not support XMLHttpRequest? It ought to find a way, if possible, to provide all (or at least some) of its functionality by other means. For example, some remoting toolkits will use a hidden iframe to provide fake XHR support to the page.

Figure 5.1 lists a handful of such frameworks, and shows what each attempts to provide to developers. The Dojo Toolkit, JSON-RPC, and Prototype are all pure JavaScript frameworks that are agnostic about the world of the server side (although Prototype was built with Ruby on Rails in mind).

iframes

Prior to the broad adoption of the XMLHttpRequest object, many web applications were using a hidden iframe to accomplish in-page round trips back to the server. An iframe is just like a normal HTML frame (a container that can be targeted at a URL and render the results) except that it is embedded in another page. These applications simply created an iframe of 0px by 0px, then caused it to refresh against a given URL in order to pull more data back from the server.

While the technique is valid, and worked for many, there were two inherent problems. The first is, if you wanted multiple asynchronous requests, you had to have multiple iframes. This became a game of guessing how many you would need and embedding that many in the page, which is not a tremendous burden, just somewhat ungainly.

More important is the question of *coding intentionally*: the use of iframe is a quintessential kludge. By that, we mean it's the repurposing of a technology to do something it wasn't quite meant to do. Though it works, it always feels a little like cheating. XMLHttpRequest, however poorly named, is an object specifically designed for initiating, monitoring, and harvesting the results of in-page postbacks. Programming against it feels natural, and lends itself to more readable (and therefore maintainable) code.

A third issue, that mainly affects IE, is that the iframe issues audio feedback to the user whenever it makes a request. This comes in the form of a "click" sound, which can be jarring for the user since they usually have no other indication of ongoing asynchronous behavior.

Toolkit Resources

- Dojo: http://dojotoolkit.com
- Prototype: http://prototype.conio.net/
- Script.aculo.us: http://script.aculo.us
- DWR: https://dwr.dev.java.net/
- Backbase: http://www.backbase.com
- SmartClient: http://www.isomorphic.com
- Ajax.NET: http://ajax.schwarz-interactive.de/
- SAJAX: http://www.modernmethod.com/sajax/
- JSON-RPC: http://json-rpc.org/

Others, such as DWR (Direct Web Remoting), couple a JavaScript client library with a server-side listener piece written for the Java platform. JSON-RPC itself has various bindings for many back-end languages.

DWR, JSON-RPC, Ajax.NET, and SAJAX are all examples of ORB-based Ajax frameworks. They allow you to map JavaScript methods to back end services, treating the client-side JavaScript as though it could directly access your server-side objects.

UI Toolkit

Above, or potentially alongside, remoting toolkits we find JavaScript UI libraries. These give us the ability to use rich UI components and effects out of the box, but differ in many ways.

Richer UI Components

Toolkits such as Dojo give us rich widgets like trees, tabbed panes or menus. These are self-contained, instantiable UI components that can be used to compose a rich, though still very “web-ish” application. The result is still unmistakably an HTML UI.

Web Application Toolkit

Toolkits such as SmartClient aim to give you widgets that build a UI that looks and feels the same as a native application on Windows or Mac OSX. These are useful if you are building an application that happens to be on the web, versus a website that uses a couple of UI effects and components. SmartClient, for example, features widgets that make the page look and feel exactly like a Windows NT application.

Markup Based

Backbase allows you to add rich components through a markup programming API. Your traditional HTML becomes something like:

File 4

```
<xmp b:backbase="true" style="display:none;" xmlns:nav="http://www.backbase.com/site/nav">
        <s:event b:on="construct" b:action="show"/>
        <!-- everything that is never shown - in here -->
        <div style="display:none;">
                <s:include b:url="/chrome/bb3/skin.xml"/>
                <s:include b:url="/data/navigation.xml"/>
                <s:include b:url="/data/forms.xml"/>
                <!-- listeners for links to non-BDOC documents... -->
                <div id="forum">
                        <s:event b:on="nav:show-page" b:action="select" b:target="id('forumBuffe
                </div>
                <div id="/shop/">
                        <s:event b:on="nav:show-page" b:action="select" b:target="id('shop_main_
                </div>
                <!-- Contains references to protected buffers -->
                <!-- Trigger 'command' event to issue bufferdirty on them all -->
                <div id="clear_protected_trigger">
                        <s:event b:on="command">
                                <s:task b:action="trigger" b:event="command" b:target="*" b:tes
                        </s:event>
                </div>
        </div>
        <!-- Include shop -->
        <s:include b:url="/shop/shopIndex.html?cmd=index" />
        <!-- ... -->
</xmp>
```

Such a system could potentially enable a new generation of visual development tools. Part of the problem with such tools is the conflict between markup and code. Traditional JavaScript-based pages have caused problems for such tools because it is difficult to provide visual representations of code resources. An all-markup framework, on the other hand, would provide the right abstractions for these kinds of development environments. See, for example, the markup-based components in ASP.NET, Tapestry and Java Server Faces.

Simple JavaScript Driven Effects

In Chapter 6, *Ajax UI, Part I*, on page 89 and Chapter 7, *Ajax UI, Part II*, on page 115, we'll look at several frameworks that use pure JavaScript and HTML to create extremely complex UI effects. These kinds of frameworks provide high-level abstractions on top of some meaty JavaScript, making the effects simple to implement in your application. The results are often completely cross-browser compatible, and fail gracefully to static HTML in legacy browsers.

Ajaxian Web Frameworks

At the top of the tower are the web frameworks that are aware of Ajax. This is a growing group, and covers all of the platforms. All the major players are represented: Java, .NET, Ruby, PHP, Python, Perl, etc.

Once again, the various frameworks offer different models for how you can work with them in an Ajaxian world.

Code Generation

The Ruby on Rails community jumped on Ajax like nobody else. They offer high-level Ruby helper functions which generate Prototype-based JavaScript code. WebWork2 is doing the same thing on the Java platform, utilizing the Dojo Toolkit as the base JavaScript framework. Many other frameworks are following suit, from Spring to CherryPy to PHP.

Component-based

ASP.NET had Ajaxian components before there was Ajax. Other frameworks such as JavaServer Faces and Tapestry on the Java platform join ASP.NET by letting you use components that may happen to use Ajaxian techniques. In this world, you drag your DataTableComponent onto your designer view and start tweaking the property sheet for that component. Here you may see a checkbox for *auto-update*. Simply checking that box will put this component in Ajax mode and the rest is history.

5.2 Remoting with the Dojo Toolkit

Now that we've examined the landscape of available helper toolkits, we'll port Hector's CRM application to several of them to see how they work. Hector's CRM system is working OK with our low-level XMLHttpRequest

example from the previous chapter, but we want to move up the stack and utilize a remoting toolkit to abstract away browser compatibility issues and give us more options for controlling the remoting calls.

We will first port our application to use the Dojo Toolkit,[1] explaining choices that you have along the way, and finally discussing more advanced features.

What is the Dojo Toolkit?

Dojo is a *browser toolkit*. It is an open source project, that (to quote its marketing text) aims to "allow you to easily build dynamic capabilities into web pages and any other environment that supports JavaScript. Dojo provides components that let you make your sites more useable, responsive, and functional. With Dojo you can build degradeable user interfaces more easily, prototype interactive widgets quickly, animate transitions, and build Ajax-based requests simply."

It is a full featured toolkit that has many packages including:

- dojo.io: The core package that we will look at in this chapter, that makes Ajax requests easy.
- dojo.event: Browser compatible event system.
- dojo.lang: Support for mixins, and object extension.
- dojo.graphics: Support for nifty HTML effects (e.g. fadeIn/Out, slideTo/By, explode/implode, etc).
- dojo.dnd: Drag and Drop support.
- dojo.animation: Create animation effects.
- dojo.hostenv: Support for JavaScript packages (think imports/includes instead of having to create script src="...")

Porting CRM to dojo.io.bind()

This chapter is all about the remoting layer, and in Dojo that means the dojo.io package. We are going to go from where we left off with the CRM application, and replace the raw XMLHttpRequest object with a call to dojo.io.bind()

[1] http://dojotoolkit.org

autocomplete="off"

As part of cleanup, we added the HTML attribute autocomplete="off" on the city and state input values. This stops your browser from trying to do its own completion, which gets in the way when the value is being set by a return from Ajax.

Cleaning up the JavaScript

Before we even get into Dojo, we should clean up the JavaScript a little and encapsulate the acts of assigning the city and state in the form, and announcing errors. Until now these acts were hidden in the callback function used by XMLHttpRequest.

First, we create a function that assigns the city and state:

File 11

```
function assignCityAndState(data) {
        var cityState = data.split(',');
        document.getElementById("city").value = cityState[0];
        document.getElementById("state").value = cityState[1];
        document.getElementById("zipError").innerHTML = "";
}
```

Then we have a simple error assignment procedure:

File 11

```
function assignError(error) {
        document.getElementById("zipError").innerHTML = "Error: " + error;
}
```

With this simple abstraction, we will be able to use any remoting solution and reuse these functions.

Migrating to dojo.io.bind()

Now we get to the Dojo IO package, and in particular, a dojo.io.bind() function that encapsulates remoting. Everything you need to do with remoting can be done with this simple function. dojo.io.bind() takes a hash as input, using the values to initialize the underlying XHR object and register callbacks to other JavaScript functions.

First, we have to include Dojo by including the correct JavaScript in our HTML head element:

```
<script language="JavaScript" type="text/javascript" src="../scripts/dojo/dojo.js"/>
```

Let's take a look at the code that now does the Ajax request for the zip data:

File 11

```
function getZipData(zipCode) {
        dojo.io.bind({
                url: url + "?zip=" + zipCode,
                load: function(type, data, evt){ assignCityAndState(data); },
                error: function(type, error){ assignError(error); },
                mimetype: "text/plain"
        });
}
```

The must-have element in the dojo.io.bind() parameter is the url key. In our example it will become /ajaxian-book-crm/zipService?zip=53711 if you are looking up a Wisconsin city.

The load key takes a function object as a callback. After the Ajax request has loaded a response, this function will be called (think of this as being the callback when the status from a XMLHttpRequest is the magic 4). In your callback you get access to:

- type, which tells you whether the response returned normally (load) or from an error condition (error)
- data, the actual response (harvested from XHR.responseText). This is the payload of the request.
- evt, a DOM event

The error key handles errors, whereas load handles requests that went through nicely. The function callback gets access to the error message itself in its second function parameter.

The mimetype key is important. We have discussed how there are various styles of remoting, and how you can choose to return HTML, JavaScript, or your own text. Here, we decided to use text/plain, get back the city/state information as the string Madison,WI, and split up for our usage.

Changing dojo.io.bind() to Use a Return Type of JavaScript

Now we have our Ajax request encapsulated in one simple dojo.io.bind() function call. This is a lot more elegant than using the raw XMLHttpRequest API, and we will soon see how we have access to features above and beyond the simple requesting and retrieving of data.

What if we wanted to talk to a service that responded directly with JavaScript for us to evaluate, instead of a proprietary String that we

Generic Handle

Rather than separating the load and error handlers, in theory you can use one handler named handle. This is when you would use the parameter, and would probably check against it to see how you were called. We could have written the same example as:

```
handle: function(type, data, evt){
        if (type == "load") {
                assignCityAndState(data);
        } else if (type == "error") {
                assignError(error);
        } else {
            // could potentially handle other types!
        }
},
```

needed to parse? For example, instead of returning "Madison,WI", the service could return:

```
document.getElementById('city').value = 'Boulder';
document.getElementById('state').value = 'CO';
```

Making this change is quite trivial with Dojo, and it will simplify our code even more. We can get rid of the assignCityState() call itself, and there is no need for a load() function, as that is taken care of due to the fact that Dojo will automatically load a JavaScript result from the server if we tell it via the mimetype text/javascript:

File 10

```
function getZipData(zipCode) {
        dojo.io.bind({
                url: url + "?zip=" + zipCode + "&type=eval",
                error: function(type, error){ assignError(error); },
                mimetype: "text/javascript"
        });
}
```

Notice that we added &type=eval to the URL, to make sure that the server sent us back JavaScript this time.

Advanced Features of dojo.io.bind()

Hopefully at this point you have seen that it makes little sense to use the low level API when you have a nice, clean, simple interface that Dojo gives you. It turns out that dojo.io.bind() can do a lot more for you. For one, it is able to do browser detection, and makes sure that it finds the

Transport Enforcement

Sometimes, we don't want graceful, transparent failover. If, for some reason, we must mandate that only certainly kinds of post-back transport mechanisms be used, we can pass in our rule on the dojo.io.bind() call. If we want to enforce one transport only, we can do so by setting

```
transport: 'XMLHTTPTransport'
```

in the hash that we pass in.

right XMLHttpRequest object for your browser. If it can't find one, it can drop back to iframes to do the deed. All of this happens transparently to the developer.

Submitting Forms

Dojo can to submit a form asynchronously for you as well as accessing a given URL. All you need to do to submit your form is tell Dojo about the form element in your HTML via:

```
dojo.io.bind({
  url: "http://your.formsub.url",
  load: function(type, obj) { /* use the response */ },
  formNode:  document.getElementById('yourForm')
})
```

C'est toute.

Support for Browser back/forward Buttons

This feature is a gem. One of the issues with using XMLHttpRequest vs. an iframe is that iframe events are placed in the browser history, while XHR events are not. This can cause an issue if a user clicks on something that causes an Ajax request which changes the page, and then they hit the back button assuming that it will take them to the state they were in before that request. Instead, they are taken to the page before the Ajax code (which could be away from your website!).

Dojo allows you to tie into the browser buttons, passing in the work that you want to do when a user clicks on back or forward. In our CRM example, you could save the current city and state information

and clean it out in the form when the user clicks "back". Then, if the user clicks "forward" you could reset it into the form without having to go back to the server.

```
backButton: function() {
        saveCityState();
        cleanCityState();
},
forwardButton: function() {
        setupCityState();
},
```

How does Dojo do this? Is there a nice API that Firefox and IE give you to hook in? No. The actual implementation differs depending on the browser, but at a high level Dojo creates a hidden iframe, makes it go forward two requests, and then one back. Now, it is setup ready to do your bidding. If you click on back the onload event will call into your backButton callback. Ditto for the forward button.

Bookmark-ability

Another UI issue with Ajax applications is making sure that the bookmark paradigm still works. We have all seen Ajax applications that are just one page, and hence you can't bookmark anything (Google's Gmail is sometimes bad like this).

Dojo gives you a simple hook to change the URL, and hence potentially allow for bookmarking events that happen within an Ajax world.

To turn on this feature you have to set the changeURL parameter in your calls to dojo.io.bind(). You can set it to either:

- true: changes the URL to the form http://yoursite.com/yoururl.html#12345678, where the content after the hash mark is a timestamp.

```
dojo.io.bind({
  url: "http://your.sub.url",
  load: function(type, obj) { /* use the response */ },
  changeURL: true
})
```

- yourownvalue: The given string will be added to the url. If you set

```
dojo.io.bind({
  url: "http://your.sub.url",
  load: function(type, obj) { /* use the response */ },
  changeURL: "ajaxian"
})
```

  the URL will be changed to be http://yoursite.com/yoururl.html#ajaxian

Miscellaneous Options: method, content, postContent, sync, and cache

You can pass other (rarely mentioned) options to dojo.io.bind().

- method: You can set the HTTP method to use for the request ("get" or "post", for example)
- content and postContent: You can think of this option as the request parameters that you wish to post up to the server in a hash form.

  ```
  "content: { key1: 'value1', key2: 'value2' }"
  ```

  postContent is only sent if the method is POST, allowing you to selectively push certain values on post requests only.
- sync: By default your requests are asynchronous (which is good), but you can set

  ```
  sync: true
  ```

  to change that.
- useCache: Dojo can use a cache that you can dip into to bypass server access. To turn this on you must set

  ```
  "useCache: true"
  ```

5.3 Remoting with the Prototype library

Prototype jumped onto the scene with the rise of the popular Ruby on Rails web framework. The Prototype library is another open source JavaScript toolkit which provides a straightforward wrapper around XHR and some foundational UI effects. We'll port Hector's app to use the Prototype remoting capabilities in order to contrast it with Dojo.

Porting to Prototype

Since you have already seen the port to a remoting framework, this will probably look similar. First, we need to point our browser to pickup the Prototype library:

```
<script language="JavaScript" type="text/javascript"
    src="../scripts/prototype/prototype-1.3.1.js"/>
```

Ajax.Request()

The dojo.io.bind() equivalent in Prototype is Ajax.Request(). It works in a similar way to dojo, in that you pass in most of the information as an object with callbacks. The CRM example is:

File 14
```
function getZipData(zipCode) {
        new Ajax.Request(url, {
                asynchronous: true,
                method: "get",
                parameters: "zip=" + zipCode,
                onSuccess: function(request) {
                        assignCityAndState(request.responseText);
                },
                onFailure: function(request) {
                        assignError(request.responseText);
                }
        });
}
```

The differences are subtle. First, you pass the url as the first parameter to Ajax.Request() rather than in the object hash itself. You will also see that you can choose between a synchronous or asynchronous request. 99.99% of the time you will want to use asynchronous, because you don't want to freeze the browser while the request happens. You also get to choose the HTTP method (GET, POST, and so on) and the parameters that we want to add to the URL itself. Finally, the callback functions get the XMLHttpRequest object itself, so you can grab the responseText, responseXML, or anything else that you need from that object.

Evaluating the Return as JavaScript

If you wish to use the model of having the server return JavaScript for you to run, you can implement this by doing eval() yourself in the onSuccess callback function.

File 12
```
function getZipData(zipCode) {
        new Ajax.Request(url, {
                asynchronous: true,
                method: "get",
                parameters: "zip=" + zipCode + "&type=eval",
                onSuccess: function(request) {
                        eval(request.responseText);
                }
        });
}
```

Returning HTML to the Client

Ruby on Rails favors the technique of having HTML returned from the server, and putting that HTML into the DOM via the innerHTML property. Since Prototype is a good sister to Rails, it makes this very simple on the JavaScript side.

The trick is that you need to make sure the content that you wish to change has been given an id= attribute. Then, we can use an Ajax.Updater() that makes the XHR request, gets the output, and writes it to the element with the given id.

In our CRM example this is a two step process. First we tag the city and state HTML content that we wish to replace:

File 13
```
<tr id="rewrite">
    <th>City:</th>
    <td><input id="city" type="text" name="city"/></td>
    <th>State:</th>
    <td><input id="state" type="text" name="state" size='3' maxlength='2'/></td>
</tr>
```

Then we associate an uppdater with the element with id="rewrite" by wiring up the Ajax.Updater().

File 13
```
function getZipData(zipCode) {
  new Ajax.Updater("rewrite", url, {
    asynchronous: true,
    method: "get",
    parameters: "zip=" + zipCode + "&type=html",
    onFailure: function(request) {
            assignError(request.responseText);
    }
  });
}
```

5.4 Wrapping Up

We took the raw XMLHttpRequest version of the CRM application, and showed you how quality JavaScript libraries such as Dojo and Prototype can lift up your level of abstraction. There are no more magic state numbers, odd try/catch blocks, or the like. Dojo even offers advanced features like back/forward button support, which have largely been unavailable to JavaScript programmers until now.

Next, we'll look at the frameworks that provide support for UI manipulation, and see how they combine with these techniques to give us real power over the user experience.

Chapter 6

Ajax UI, Part I

In the last several chapters, we gave you an earful about what Ajax is, what it isn't, and where it came from. By now, you've seen the "asynchronous" and "xml" parts. Over the next two chapters, we're going to introduce you to the "JavaScript" and flashy UI parts of the framework. You'll get to see the CRM application grow into a full-fledged rich client application and learn some of the emerging standard patterns for Ajaxifying the UI. Perhaps most importantly, we'll walk you through a cautionary tale about going too far, and knowing when to say when.

6.1 Ajax and JavaScript for the UI

Dynamic HTML. The words roll around your brain and make you think of Nirvana, Lewinski and Razorfish. DHTML was so '97. Most readers may now be wondering "what's Ajax got that DHTML didn't have?" The answer, it turns out, is fairly complex. But it starts with maturity.

When we were doing DHTML apps back in the '90s, browsers were still duking it out over the best way to render tables. Heck, we didn't even have <*div*> tags until the late '90s. Cascading stylesheets were just coming out, and the language hadn't settled yet. There were browser-specific extensions to the DOM and the CSS language, and browsers couldn't even be trusted to render their own extensions properly on a consistent basis.

Fast forward to 2005. Browsers are still disagreeing about the best way to render certain tags, and there are still browser-specifc extensions to worry about. But the amount of commonality between modern browsers has grown immensely in the intervening years, leaving a

much greater common ground. Gone are the days when you had to have browser-specific rendering of simple CSS styles. We have a much broader scope of acceptable UI techniques that will work anywhere now. This kind of common ground, which eliminates the need for vast tracts of browser-specific JavaScript and CSS, makes the development of rich client apps much more straightforward and accessible.

Further, when we were developing DHTML applications back then, we didn't have the benefit of universal XMLHTTPRequest support. Sure, IE4 had it built in as an ActiveX component, but that can hardly be considered universal. Justin remembers teaching die-hard Windows web developers about it in '99 and getting a lot of odd stares in response, so even for those developers to whom it was available, it wasn't widely used. And without an asynchronous, embedded channel back to the server, DHTML applications were just about pop and flash. They added only marginal usability improvements in and of themselves, and if we wanted to make them talk back to the server, we ended up jumping through major hoops.

Think of that most ubiquitous of DHTML widgets, the tree nav. It was easy to write DHTML-based trees. It involved a couple of CSS styles, some onclick handlers and some crossed fingers, but it didn't amount to much effort. And, in return, we got collapsible, expandable tree navigation. What we didn't get, unless we put in endless hours of effort, was a way to update portions of the tree from the server without reloading the whole thing. So we ended up putting the tree in a frame, all by its lonesome self, and refreshing it *en toto* whenever the app demanded. This made for tortured JavaScript and a less than ideal user experience.

We even went so far as to invent the iframe to allow us to execute background threads of operation. As we saw previously, the iframe was a convenient, if nonstandard, way to cause a secondary request to be sent to the server. JavaScript can modify the src= attribute to cause a new request to be spawned. This seems, at first glance, to provide everything XHR provides. Dig down, though, and you'll see some problems. iframes provide no graceful method for checking on the state of a request; once fired, either the iframe renders its results or it doesn't. Secondly, the iframe automatically renders the response sent back from the server. If the response isn't HTML, the iframe must be navigated, DOM-style, to retrieve the results. All this is effective, but hardly efficient, and certainly not elegant.

The ability to exert fine-grained control over pieces of the UI only truly

becomes profound when we also exert similar fine-grained control over the data we are retrieving from the server. Being able to flash the background color of a <*div*> tag as the user mouses over it is pretty; being able to auto-update a text search box as the user types into it is an actual usability improvement. The code to control the UI of the latter is not appreciably harder than for the former; it is the access to an asynchronous trip to the server to fetch more information that makes it special.

Ajax Encourages OO Over DOM

The biggest change from DHTML to Ajax has to do with the way we think about JavaScript code in the browser. In good old DHTML, we wrote JavaScript to manipulate the DOM; we treated the DOM as a giant repository of dumb entities, each with a collection of styles appended to it. We walked the DOM using nightmarish

```
element.parent.parent.sibling.child
```

style code, and when we got there, we set text properties to be interpreted as style changes in the rendering engine. We wrote our common code as a series of functions, devoid of organizing classes or conventions. None of this looked like the server side code we were writing; it certainly didn't feel modern in any way. JavaScript was an adjunct to our "real work," and it showed.

Ajax strives to treat JavaScript in the browser as the first-class programming environment it can be. Instead of writing procedural programs, we write class libraries to encapsulate our behavior. Instead of treating the DOM as a collection of dumb elements, we treat it as a hierarchy of types. Instead of thinking of styles as strings to be constructed and parsed, we think of them as properties of objects, to be modified individually. We write modern OO code, complete with error handling, instance methods, static methods and type hierarchies.

Even better, though, we write this modern OO code using a language more expressive than the statically typed languages we use on the server. With JavaScript, we can extend types without modifying the base code. If we want to add functionality to the document object, we can declare a new function name and supply it with an anonymous definition. This new function has full access to the instance data of document, and can be called by any other type contained in our JavaScript. Functions can be sent around like data objects, invoked without know-

ing the originating instance. In other words, metaprogramming without extraneous reflection syntax.

We say that Ajax *encourages* this style of programming. There is nothing inherent about Ajax that mandates this, however. You can happily write the same old style of procedural, DOM-oriented JavaScript code and achieve Ajax effects. The frameworks that have sprouted up around Ajax, though, all eagerly pursue the more modern, object-oriented style of programming. They supply common APIs and types through which to modify the look and behavior of elements in the DOM. They provide better ways to navigate the DOM for specific items, as well. Typically, these frameworks accomplish these goals through object-oriented libraries and metaprogramming. For example, the Scriptaculous library adds a new method, getElementsByClass(), to the document object at the root of the DOM model. By injecting this method into the existing class, we get a more convenient method for navigating our DOM tree, through OO methods.

Common UI Frameworks

With the creation of the Ajax moniker, there has been a concomitant explosion of JavaScript libraries to help users take better advantage of the technology shift. Instead of making users find their own paths through the desert to the OOasis, these libraries drastically shorten the learning and adoption curves for Ajax. We've already talked about them at some length in the previous chapter; there, we focused on the libraries' efforts to encapsulate the remoting features of JavaScript. Here, we'll discover what they do for our UI code.

The first area is DOM navigation. The DOM model is a beast to get around in; as much as it seems like navigating an XML infoset should be a highly standard operation, there can be interesting differences between navigation commands and their results as you move from browser to browser and version to version. Even if there weren't, though, navigating the DOM requires too much intimacy with the overall hierarchy of the current page. Puttering around the DOM tree, using .parent references and .children collections often leads to finding the wrong element, or finding no element at all.

The major UI frameworks find ways to help you around this problem. In addition to the standard getElementById() method, these frameworks allow you to discover elements by class, by style, by tag, and a variety of other options. They give you ways to treat elements and their

names interchangeably, so that you can pass either to a function and get the correct result. Mostly, they provide handy shortcuts to tedious navigation commands, usually with more predictable results.

Affecting the look and style of DOM nodes is a painful exercise in string-based CSS styles, element property modulation, and general mucking about trying to get the element to look or act the way you want. Do you use the visible or hidden property? How do you increase the size: in pixels or percent? What's the best way to move an element around the page? The answers are usually an ungainly mix of techniques which seem to feel more like guesswork than solid programming.

Good Ajax libraries take the guesswork and pain out of manipulating element styles. Instead of having to guess what mix of properties you have to modify to get the desired behavior, certain typical and canonical effects are canned and supplied to you through a single method call. Users can modify the default behavior of the effects, or combine them in unique ways to achieve tailored results.

In this chapter, we're going to examine three major frameworks in heavy use today: Prototype, by Sam Stephenson, Script.aculo.us, by Thomas Fuchs, and Dojo, by the Dojo Foundation. There are other libraries out there worth keeping on eye on as well, such as Rico (http://openrico.org/rico/home.page), which grew out of the development for Sabre Airline Solutions. We're sure that, between now and when you read this, more frameworks will have popped up, so keep on the lookout.

Remember the figure back in the ??, on page ??? That chapter looked at the frameworks that live at the lowest level, the remoting toolkits. This chapter moves up one layer on the chart, to examine the toolkits that deal directly with UI issues. It turns out, there's plenty of overlap.

Prototype

The Prototype library is the grandaddy of them all. Other JavaScript libraries (notably, Scriptaculous) are built on top of the basic functionality provided here. Prototype is a relatively simple JavaScript file; clocking in at 1041 lines of code as of version 1.4.0_pre2, it manages to pack an enormous punch for dealing with UI issues in the browser. We've already covered what Prototype does for remoting in earlier chapters. Now we'll examine how it replaces the standard DOM and CSS idioms for manipulating UI elements.

Extensions to Common Types

Prototype adds a series of helpful utility methods to our lexicon, either by providing globally accessible functions or, in some cases, extending existing types in JavaScript or the DOM. Since JavaScript types can be extended at runtime without modifying the original source (the very definition of a *dynamic language*), this is relatively straightforward to do. The result is that Prototype can provide extremely useful shortcuts to common functionality, but present it in the most natural way possible: as properties and methods of the types where we would expect such features to appear.

Prior to the Ajax libraries, the two most common lines of JavaScript found in DHTML applications were:

```
var myElem = document.getElementById('some_element');
var myValue = document.getElementById('some_other_element').value;
```

Though this code is not particularly glaring, it is difficult to read, and can make even the simplest of functions difficult to scan and understand. Bear in mind, also, that bandwidth is (even today) an expensive resource. For evidence, I present the current crop of JavaScript compressors with which you can eliminate all the whitespace from your scripts to provide for quicker downloading. Given that the above code is ubiquitous and oft-repeated, it would make sense to find a way to minimize the surface area of these statements. Prototype replaces them with the following lines:

```
var myElem = $('some_element');
var myValue = $F('some_other_element');
```

Even better, $() can take an arbitrary number of IDs and return an Array of elements to match them.

```
var elems = $('element_one', 'element_two', 'element_three');
for(var i=0;i<elems.length;i++) {
   elems[i].value = "changed";
}
```

There is a major caveat to this technique, though. Prototype doesn't bother to check if the ID you passed is valid within the document. In the case above, if there's no element with id element_two, the call still returns an array of length 3. The second element, however, is null instead of a reference to a DOM node. Also bear in mind that $F() only works for input elements. If you are looking for the text contained within an arbitrary DOM node, $F() is useless.

innerHTML Limitations

According to the documentation for IE, the innerHTML property is read-only for the following list of enclosing tags: COL, COLGROUP, FRAMESET, HTML, STYLE, TABLE, TBODY, TFOOT, THEAD, TITLE, TR. Which means, in IE, that you cannot use the innerHTML property to set the contents of a table row. This works fine in all other browsers, but can be a serious limitation to cross-browser effects.

Prototype also extends the document object to include the new getElementsByClassName() method. You pass in the string name of a CSS class and the function will collect all the elements in the DOM who contain that class in their class list. It doesn't matter if the class name is the first or only entry in the element's list, Prototype will still find it.

```
<div id="one" class="class1"/>
<div id="two" class="class2"/>
<div id="three" class="class1"/>
<div id="four" class="class2, class1"/>
<script type="text/javascript">
   var classOnes = document.getElementsByClassName('class1').length; // 3
   var classTwos = document.getElementsByClassName('class2').length; // 2
   var classThrees = document.getElementsByClassName('class3').length; // 0
</script>
```

This method only takes a single class name, though. It is up to you to make any sort of union if you are looking for elements implementing one of a list of classes.

Once you can successfully retrieve nodes from the DOM, the next step is manipulating them. Among the most common things to do is to simply change the content of a node by resetting the value of its innerHTML property. innerHTML is just a string representation of the contents of the node. If you fill it in with properly formatted HTML, the browser will render it as such. When you retrieve it, the HTML tags will be embedded in the returned value. Sometimes, you will want to maintain the tag structure in its original format. Other times, you'll want to actually display the tags as strings rather than have them rendered as HTML. Prototype extends the JavaScript String class with some new methods. escapeHTML() returns the innerHTML, but with any HTML tags escaped so they can be displayed as text. unescapeHTML() does the exact opposite. This is very useful for displaying HTML source within an HTML page.

A final case is when you want to eliminate the tags altogether. Imagine a div that contains a bibliography entry, rendered so that the title of the book is underlined and the author's name is boldfaced. You want to retrieve that value as data; any embedded style notation (or, Heaven help us, <b> tags) are extraneous. String now has the stripTags() method which eliminates any angle brackets (and what's inside them) from the output. Whitespace is otherwise maintained, allowing you to treat HTML as raw data.

Element

Prototype introduces a new class, Element, that controls some basic styling properties of a DOM node. Element is a *static* class, in that you need not create an instance of it to access its functionality. Its various methods all take an element ID or an element itself as a parameter and perform some action on them.

We spend a lot of time hiding and showing nodes of a DOM tree. Error messages are invisible unless validation fails, for example, or trees contain collapsible nodes. Most of the dynamic nature of a web page is wrapped up in the mysterious appearance and disappearance of blocks of data. The standard JavaScript strategy for accomplishing that uses the .style.display property.

```
<div id="hideOrShow">
   You can turn me on and off.
</div>
<input type="button" value="Toggle" onclick="toggle('hideOrShow');"/>
 <script type="text/javascript">
    function toggle(elemName) {
      var elem = document.getElementById(elemName);
      if(elem.style.display=='none') elem.style.display = '';
      else elem.style.display = 'none';
    }
 </script>
```

Element provides the .toggle command which accomplishes the exact same thing, but with the added benefit of being able to pass in as many element names (or elements) as you like to a single call. Toggle will iterate over all the arguments, toggling the state of each in turn. This provides a convenient way to swap visibility of elements.

```
<div id="up">
   <img src="images/up.gif"/>Up
</div>
<div id="down" style="display:none;">
   <img src="images/down.gif"/>Down
</div>
```

```
<input type="button" value="Toggle"
   onclick="Element.toggle('up', 'down');"/>
```

To be sure, we don't always want to toggle. Element also exposes show() and hide(), which each take a variable number of elements as arguments, and ensures that each has its display property set correctly. Sometimes, though, toggling isn't enough. Setting an element's display property to "none" renders the rest of the page layout as though the element did not exist in the DOM at all. However, the mere existence of the element might have other effects. If the hidden element contained form elements, for example, they would be submitted to the action as though they were visible. The same is true for scripts that traverse the DOM elements or manipulate page layout.

Instead of merely setting the div's display property to "none", we can remove the <*div*> from the DOM tree entirely. Normally, this would mean navigating to the <*div*>'s parent node and removing the div from the parent's children. The DOM specifies a removeChild() method specifically for this purpose. The node is removed from the tree, and the entire tree re-rendered to keep that block from influencing the flow. Furthermore, containing elements no longer have any knowledge of the node, and scripts will not be able to discover it. This is nonreversible, unless you have cached a copy of the node in another variable and add it back manually later. Prototype exposes the removeChild() feature as a function called Element.remove().

Inserting Data

Showing and hiding data is nice, but it implies that we have a nice container dedicated for displaying that piece of data. Showing an error message, for example, usually means that we have a hidden div or span standing by to take that data, then display it to the user. Quite often, though, what we want to do is add more data to an existing, visible element. Most commonly, we want to add items to an already-visible list of items. The standard DHTML way to do this is to recreate a new version of the list items which include the additions, then replace the contents of the list with the new version. With Ajax, this would mean having a server-side method which you call that sends the list back with any new items appended. While effective, this might be extremely inefficient. The code that generates the content of the list might be long-running, and, if it involved a database, mandates at least a round trip to the datastore to re-fill the list.

Prototype introduces the Insertion class. Insertion allows us to add information to an existing container without replacing what currently exists in the list. Insertion.Top() enters the new data at the beginning of the container's body, while Insertion.Bottom() enters it at the end. This means that you can easily append single lines to a list without re-rendering the whole list.

```
<ul id="mylist">
          <li>one</li>
          <li>two</li>
          <li>three</li>
      </ul>
      <input type="text" id="newval"/>
      <input type="button"
             value="Add Item"
             onclick="new Insertion.Bottom('mylist',
                   '<li>'+$F('newval')+'</li>');"/>
```

Keep in mind that you have to provide the full value you want rendered. In the example above, we're appending the text value of the input field to the bottom of the list. We have to wrap it in the *<li>* tags in order to get it to render as a list item; without those tags, the new value is just pasted as text inside the list, which is rendered without the bullet, and as inline text.

Prototype actually goes a little farther, and lets you append text around the container as well. In all, Insertion offers four placements for your new data: Before(), Top(), Bottom(), and After(). Figure 6.1, on the following page demonstrates where each lives.

This is fairly powerful, since you can modify a section of the page for which you do not have an ID (or there may be no ID at all).

Forms

Working with forms has historically been a bit of a drag. Forms are useful for only one purpose: collecting data from a user. The input fields that exist on a form, though varied in style, are essentially identical in nature. They represent an item that a user can use to tell us something. Before Ajax and the re-thinking of the DOM that it brought with it, we had to treat forms and inputs just like any other HTML elements, navigating the DOM to find them, modifying their style properties to affect their behavior.

Prototype gives us tools to think about forms differently. Instead of representing a chunk of HTML that happens to have input boxes embedded in it, Prototype encourages us to think of forms as collections of data

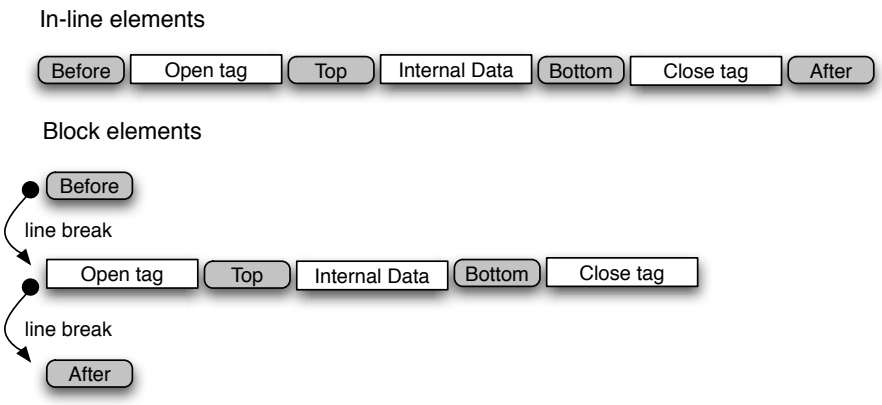

Figure 6.1: Insertion placement possibilities

fields. Using the library, we can manipulate the properties of all the fields on a form simultaneously when that suits our needs, and navigate them as an array of fields, not as scattered children in a subtree of the DOM.

The vehicles for this change are the new classes Form and Field. Field provides three major UI-related methods:

- select(): selects the current value of the field
- focus(): moves the focus to the field
- activate(): a combination of select() and focus()

For example, you could create a form with certain form fields visible at all times, but a second set of more advanced options only visible when the user requests them. For convenience, you would want the user to begin typing into the topmost field immediately upon making it visible, which you could accomplish with activate.

```
<form action="postback.jsp" method="post">
      First Name: <input type="text" name="firstname"/><br/>
      Last Name: <input type="text" name="lastname"/><br/>
      <a href="#" onclick="Element.toggle('advanced_options');Field.activate('petsname');">
            Advanced Options</a>
      <div id="advanced_options" style="display:none;">
         Pet's name: <input type="text" name="petsname"/><br/>
         Favorite color: <input type="text" name="favoritecolor"/>
      </div>
```

Beware Before and After

Don't get too carried away with Before() and After(). While each will happily let you insert plain text or renderable markup into the document at the appropriate point, you cannot use them to create new containers around an existing item. To do so, you would have to execute two separate statements: an Insertion.Before() for the opening tag, and an Insertion.After() for the closing tag. Modern DOM rendering engines will not allow you to add malformed XML to the document. Therefore, the first call, containing just the opening tag, will have a matching closing tag inserted at the end of the value you passed in. The second call will have the closing tag simply stripped from the input.

Imagine you have an element containing a new header tag that you want to surround with a new * * tag. Your code would look like this:

```
<ul id="mylist">
   <li>one</li>
   <li>two</li>
   <li>three</li>
</ul>
<input type="text" id="newval"/>
<input type="button" value="Add Item"
   onclick="wrapList('mylist');"/>
<script type="text/javascript">
   function wrapList(listname) {
      new Insertion.Before(listname,
                  '<div><h2>New Title</h2>');
      new Insertion.After(listname, '</div>');
   }
</script>
```

When you execute this, the resulting rendered DOM tree, if you could see it using view source, would look like this:

```
<div><h2>New Title</h2></div>
<ul id="mylist">
   <li>one</li>
   <li>two</li>
   <li>three</li>
</ul>
<input type="text" id="newval"/>
<input type="button" value="Add Item"
          onclick="wrapList('mylist');"/>
 . . .
```

```
</form>
```

Form offers three more UI relative methods:

- disable(): disables every input field in the form (sets the background to gray and disallows changes)
- enable(): enables every input field in the form
- focusFirstElement(): sets the focus to the topmost field in the form

These methods allow you to work with the entire form as a single entity. For example, it is a common pattern to display information to the user that they may wish to edit. Web developers have to decide between showing them the data as plain HTML, then switching to a form view when the user chooses to edit, or just showing it to them in the form view from the get go. With Form.enable and Form.disable, the decision is easier. You can display the data in a disabled form; when the user clicks the "Edit" button, simply enable the entire form.

Position

Prototype contains several methods for understanding the current position of elements on a rendered page. Specifically, they allow you to discover the relative position on an element on a scrollable page, including whether or not the element is on the currently visible portion of the page. If not, you can retrieve the scroll offsets (horizontal or vertical) to the element from the visible section. Most developers won't use these features directly, but instead use frameworks that build on top of them to provide higher-level features (like Scriptaculous, for example).

Script.aculo.us

Thomas Fuchs has built on top of the base Prototype library to dramatically increase the number and kinds of effects that can be created with JavaScript. Script.aculo.us is the result of his efforts. Where Prototype is focused on extending the baseline capabilities of JavaScript and the DOM, Script.aculo.us allows web developers to make HTML look and act just like any other "rich client" platform. The kinds of effects range from simple hiding and showing tricks all the way up to drag-n-drop and sortability.

Effects

The library is divided between the five core effects and a series of combination effects built on top of them. The core effects are: Opacity, Highlight, MoveBy, Scale, and Parallel. Every effect represents a transition between two states that occurs over time. The effects all have default values for start and end points, as well as duration. These defaults can be overridden for a fully customized effect. The various effects each have different required parameters (for instance, MoveBy() requires x and y deltas), and each can accept any of the standard options as well. The general syntax for launching an Effect is:

```
new Effect.EffectName( element, required-params, {options} );
```

The effects are all asynchronous which means that if you launch several effects simultaneously they will render simultaneously. This is true whether the effects target different elements, or all target the same element. Quick-fingered users won't be surprised by browser lockups as your <*div*>s turn yellow and balloon to twice their size, and you can fade out as many deleted items from your list as you desire at the same time.

This section will examine all the possible ways to utilize the core effects from the library. In Chapter 7, *Ajax UI, Part II*, on page 115, we'll look at how to use them effectively to increase the usability of the user interface. For all their cool factor, these kinds of effects can be overused and become just another <*blink*> tag, so knowing why you would employ them is just as useful as knowing how.

The standard options you can pass to the effects are:

- duration: the number of seconds the transition will take (default 1.0)
- fps: target frames per second rate (default 25)
- transition: an algorithm for determining how to move from the starting point to the ending point. These are represented as a series of, essentially, enumerated constants. Can be one of:
  - sinoidal: start slow, peak in the middle, slow down on the way out
  - linear: constant speed from start to end
  - reverse: constant speed, but from end to start

  - wobble: reverse direction several times during transition
  - flicker: jump to random values during transition
  - pulse: progress from start to end, back to start, back to end, repeat 5 times

- from: starting point for transition, between 0.0 and 1.0 (default 0.0). See the explanation that follows.
- to: ending point for transition, between 0.0 and 1.0 (default 1.0)
- sync: whether new frames should be rendered automatically (default true)

Think of from and to as percentages. If you are using the MoveBy() effect to move an element 50px to the right and 50px down, then the starting point (0.0) represents the original positions, and the ending point (1.0) represents the original position +50px in both directions. However, if you launch the effect using the following options:

```
new Effect.MoveBy( 'movable_element', 50, 50, {from: 0.0, to: 0.5} );
```

then the actual endpoint would be the original position plus 25px in both directions, since your to: option requires the transition to end halfway through. The transition option just determines what algorithm to use to progress from the from: option value to the to: option value. Flicker, for example, uses the following algorithm:

```
return ((-Math.cos(pos*Math.PI)/4) + 0.75) + Math.random(0.25);
```

Effects also allow you to bind callbacks to various stages in the transition cycle. The callbacks are also asynchronous. The only caveat to this is that, in some browsers, popping up a dialog box through alert or confirm will allow the effect to progress, but its effects will be invisible until the user closes the dialog. That means that whatever state the transition is in when the dialog is closed will suddenly appear. If the transition's duration has already passed by the time the user closes the window, the effect will have finished and the user will never have been treated to your Ajaxy goodness.

Opacity

The Opacity() effect is straightforward. You can transition between an opacity of 100% to 0%. There are no specific parameters for the percentage opacity, you simply use the from and to options, using 1.0 as 100% opaque and 0.0 as 0%. If you get the element to 0% opaque

(also known as 100% transparent) you have not hidden the element in the sense that we explained before with Element.hide()—it is simply invisible. Using the Prototype Element.show() method will not make the element reappear; to do that, you would need to readjust the opacity to something above 0%. Likewise, a 0% opaque element is still taking up space in the DOM layout.

To make an element fade quietly from sight over two seconds, you could use:

```
new Effect.Opacity('some_element',
                   { duration: 2.0, from: 1.0, to: 0.0 });
```

If you wanted the element to go out like a lightbulb (flickering on and off until finally going out), you would use:

```
new Effect.Opacity('some_element',
                   { duration: 2.0,
                     from: 1.0, to: 0.0,
                     transition: Effect.Transitions.flicker});
```

To simply flash the element a few times to draw attention to it, you can fade it in and out:

```
new Effect.Opacity('some_element',
                   { duration: 1.0,
                     from: 1.0, to: 0.0,
                     transition: Effect.Transitions.pulse});
```

Movement

Effect.MoveBy() provides easy control over repositioning elements. The beauty of Effect.MoveBy() is that it doesn't require the element to have any particular placement styles already associated with it. Regardless of whether it is an inline or block element, or whether it is positioned absolutely or relatively, it can be moved around with the same call to Effect.MoveBy(). You can even run the element right off the right or bottom edge of the document, causing the page itself to sprout scrollbars to allow for the new position. Repositioning it off the top or left borders, of course, removes it from sight without affecting the overall position or size of the page.

Effect.MoveBy() has two mandatory parameters that must be specified in addition to the element name and options. They are the X and Y offsets to calculate the new position. The offsets follow a simple geometry: positive X means movement to the right, negative X means movement to the left. Positive Y means down, negative Y is up. Therefore, to raise

an element 100 pixels while moving it to the right by 20, you could use the following:

```
new Effect.MoveBy('some_element', -100, 20);
```

To shake the element in place to draw attention to it, but have it end up back at its starting point:

```
new Effect.MoveBy('some_element',
                  0, -100,
                 { duration: 2.0,
                   transition: Effect.Transitions.pulse});
```

One thing to watch out for: in the documentation at Script.aculo.us' website, as of version 1.0, the API for the call is misrepresented. The function itself takes the offsets in the order Y, X, but the documentation lists them as X, Y.

Size and Scale

The Effect.Scale() method allows you to affect the overall size of an element. Sizing can be tricky; when the element is a container for other elements, you have to know if you want the contents to scale as well as the container. If the object is going to grow, should the new size be anchored to the upper left corner of the element, or to its center? What if the element has parts that are only visible if you scroll to them? There are six Scale-specific options you can use in the {options} part of the call, if necessary.

- scaleX: whether or not the element should scale horizontally (default true)
- scaleY: whether or not the element should scale vertically (default true)
- scaleContent: determines if the content of the element should scale along with the container itself (default true)
- scaleFromCenter: keeps the center of the object stationary while expanding the four corners (default false)
- scaleMode: a value of 'box' means only scale those parts of the element that are current visible on the page without scrolling, while 'content' means scale everything (default 'box')
- scaleFrom: a starting percentage of actual size to scale from (default 100%)

Figure 6.2: Elements before scaling

Scaling a container element is tricky if you also want everything contained inside to scale along with it. Graphical subelements scale automatically with the container except <*img*> tags. <*img*> tags must be scaled independently by applying a Scale effect directly to the tag. For textual contents, the font size in the HTML page must bespecified in *em* units in order for scaling to work. Unfortunately, *em* isn't the default sizing unit for text in most browsers, so unless you explicitly apply a style to your text that sets it to em units, Effect.Scale() will ignore the text and scale the rest of the container around it.

Figure 6.2 shows a <*div*> with a contained <*div*> and some text in its original state.

```
<div id="window" style="border: solid 1px black;">
  <div id="windowbar" style="background-color: red; color: white;">
    Window title
  </div>
  Content body.
</div>
```

If you run a simple scale against this element, the container elements will scale but not the text. This call doubles the size of the elements, as shown in Figure 6.3, on the next page.

```
new Effect.Scale('window', 200);
```

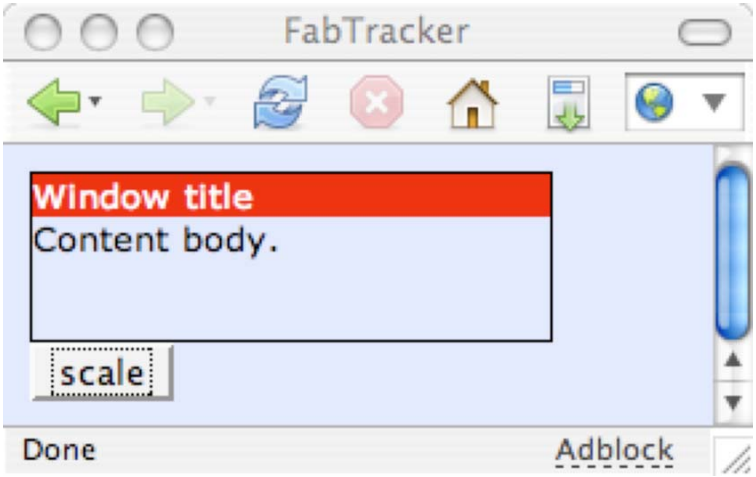

Figure 6.3: Elements after simple scaling

In order to get the text to scale along with the graphics, we'd need to apply a style to the original elements to set the text to em units. Unfortunately, em units are not the standard in any browser. If you don't size your text specifically using styles based on em units, scaled elements will look horrible by default.

```
<div id="window" style="border: solid 1px black; font-size: 1.0em;">
  <div id="windowbar" style="background-color: red; color: white;">
    Window title
  </div>
  Content body.
</div>
```

Applying the same scaling as before, we'd now get the result shown in Figure 6.4, on the following page.

Highlight

Popularized by the venerable Yellow Fade Technique (or YFT, as it is more popularly known), this effect simply transitions the background color of an element from a start color to an end color by moving through the spectrum between them. The original YFT resets the background color to a buttery yellow and fades back to white. The effect brings the eye to an element where a change has occurred, but then leaves the

Figure 6.4: Scaling text

page in a pristine state after the transitions has completed. To enable this, Effect.Highlight() has three effect-specific options you can use:

- startcolor: instantly changes background color of element to this value at the start of the effect
- endcolor: target end color to transition to
- restorecolor: sets the background color to this after transition has completed

The animation transitions between startcolor: and endcolor:, and then the element is set to restorecolor:. The three color options only accept hexadecimal color values as strings. The hex values can optionally start with '#'. You can *not* use standardized color descriptors such as "red" and "khaki" nor shortform hex values such as "f00". Here are two examples.

```
// simple Yellow Fade Technique
new Effect.Highlight('some_element');&#730;
// fade from red to blue, back to white
new Effect.Highlight('other_element',
                     { startcolor: '#ff0000',
                       endcolor:   '#0000ff',
                       restorecolor: '#ffffff'});
```

Parallel Effects

These four core effects are all very powerful by themselves. Since they are asynchronous, though, you can apply multiple effects simultaneously to get combined effects. Instead of having to wire up the combined effects yourself, Script.aculo.us supplies the Parallel() effect that takes care of it for you. Instead of supplying an element to Effect.Parallel(), you provide an array of other Effects. They don't necessarily have to all target the same element. Effect.Parallel() will kick all the child effects off simultaneously. You could, for example, use Effect.Parallel, to combine the Yellow Fade Technique and a pulsating Scale effect to really draw attention to something.

```
new Effect.Parallel(
    [ new Effect.Highlight('window', { sync: true }),
      new Effect.Scale('window', 200,
                       {sync: true,
                        transition: Effect.Transitions.pulse}),
     ],
    { duration: 2.0});
```

Combination Effects

Luckily, Script.aculo.us already provides a wide variety of combination effects using Effect.Parallel and the four core effects. Once again proving that you can build great complexity from a few simple building blocks, the range of available effects is impressive. Using the effects is no more complicated than using the core effects, either. The following is the list of combination affects available as of version 1.0.

- Effect.Appear(): sets the opacity of the element to 0, fades it up to 100, and ensures that it is visible if it was hidden
- Effect.Fade(): sets the opacity of the element to 100, fades it to 0, then hides it at the end
- Effect.Puff(): combines Scale and Opacity, growing the element to 200% while fading it out, hiding it at the end
- Effect.BlindUp(): scales the image vertically to 0, without scaling the contents. Hides it at the end.
- Effect.BlindDown(): scales the image vertically to full size, without scaling the contents. Ensures it is visible.
- Effect.SwitchOff(): turns the element off like an old TV. Uses Opacity with Transitions.flicker to go from 100% to 0%, while simultane-

ously scaling the image down to 0 with scaleFromCenter set to true.

- Effect.DropOut(): combines MoveBy and Opacity, moving the element down while fading it out.
- Effect.SlideDown(): uses MoveBy to animate sliding the contents of a <*div*> into view. Requires your <*div*> to be contained by an outer <*div*>.
- Effect.SlideUp() : opposite of SlideDown. Hides the element after the transition.
- Effect.Squish(): uses Scale to go from full size to 0, ensures the element is hidden at the end.
- Effect.Grow(): sets the size of the element to zero, uses Scale to grow the element to full size with scaleFromCenter: set to true.
- Effect.Shrink(): like Squish, but with scaleFromContent: set to true.
- Effect.Pulsate(): uses consecutive Fades and Appears to blink the item smoothly.
- Effect.Shake(): uses consecutive MoveBy effects to move the item left and right.
- Effect.Fold(): combines BlindUp and Shrink to give the appearance that the item is folding up. First, shrinks the element vertically, then horizontally, down to 0.

Advanced Techniques

Script.aculo.us also provides a series of more avanced techniques, such as Drag And Drop and sorting capapbilities. We'll examine these in detail in the next chapter.

Dojo

Dojo is a different kind of animal than Prototype and Script.aculo.us. Whereas of those libraries are smaller, and more focused on UI goodness coupled with good XHR support, Dojo is essentially an entire platform for building client applications. In addition to its XHR and effects modules, Dojo includes a JavaScript collections library, widgets and widget authoring utilities, a logging module, a math module, and lots more. As we demonstrated in the previous chapter, the beating heart

of Dojo is the IO libraries and the eventing system. We won't cover that ground again here. Instead, we'll introduce you to the idea of Animations in Dojo, and take a look at how they are used to create effects like we saw in Script.aculo.us.

Animations

A Dojo animation is an object that defines the parameters of a transition between two states. The states can be anything: opacity levels, position, color, shape. The animation itself isn't concerned with the states, only the properties of the transition itself. When you create an animation, you supply four parameters:

- curve: a representation of an algorithm for returning values between 0 and 1. Like in Script.aculo.us, this value will be used as a multiplier against the current state of the element, for creating steps or *frames* of the animation.
- duration: number of milliseconds the animation will take.
- acceleration: whether the animation is accelerating or decelerating (not implemented at time of writing)
- repeatCount: number of times to repeat the animation (-1 means loop forever)

A curve is just an object that exposes a method, getValue(n), where n is a number between 0 and 1. The return value is an array of numbers that can be used to calculate current state. For example, you could create a linear curve to move from [0,0] to [100,100], thereby tracing a line through a Cartesian plane that creates a 45 degree angle in the upper right quadrant. Or, you could create an arc curve to move from [255,0,0] to [0,0,255], thereby providing a transition from red to blue. The wiki for Dojo offers the following example of a curve implementation, representing a linear transition value set.

```
function Line(start, end) {
    this.start = start;
    this.end = end;
    this.dimensions = start.length;
    //simple function to find point on an n-dimensional, straight line
    this.getValue = function(n) {
        var retVal = new Array(this.dimensions);
        for(var i=0;i<this.dimensions;i++)
            retVal[i] = ((this.end[i] - this.start[i]) * n) + this.start[i];
        return retVal;
    }
```

```
    return this;
}
```

Dojo provides multiple pre-implemented curves in the dojo.math.curves module. They range from the simple Line curve, as shown above, to Bezier curves, circles, arcs, and more. The API is simple enough to add your own implementations. Just make sure you remember your 9th grade geometry. You simply provide an array of numbers, and the curve will be implemented upon each element in the array, with the return value being an array of the modified values.

To make the animation cause an element to transition, you have to wire up the events of the animation to the properties of the element you want to animate. Dojo's eventing library provides us this ability. To create our own FadeOut animation, we could use the following code:

```
function fadeOut(nodename) {
   var node = document.getElementById(nodename);
   var animation = new dojo.animation.Animation (
      new dojo.math.curves.Lin([100],[0]),  // linear progression from 100% to 0%
      2000,                                 // 2 seconds
      0                                     // not implemented, but must provide
   );
   dojo.event.connect(animation, "onAnimate", function(e) {
      node.style.opacity = e.x;
   });
   animation.play();
}
```

We must start the animation ourselves after it has been created. Then, as the animation progresses through the curve, retrieving values, those values are sent to the event listener. In this case, onAnimate is called for every frame in the animation, and it takes a special event argument that provides information about the status of the animation, including current values, percentage complete, designated end time, etc. Inside our anonymous listener for onAnimate, we retrieve the current value of our linear progression from 100 to 0, and use it as the value for the node's style.opacity property. This causes the element to fade out over two seconds, as per our duration parameter when we created the animation.

Effects

Dojo uses this animation system to build its library of effects. Creating an effect is an exercise in calling the appropriate method from the dojo.graphics.htmlEffects module. Each effect method returns a reference

to the Animation object itself, so you can append your own listeners or modify the properties of the animation to suit your specific needs. To create a fadeOut animation, for example, you could use:

```
var node = document.getElementById('some_element');
var fader = dojo.graphics.htmlEffects.fadeOut(node, 2000);
fader.play();
```

If you wanted the element to be removed from the page after fading all the way out, you can utilize the optional third parameter to include a callback function for the onEnd event.

```
var fader = dojo.graphics.htmlEffects.fadeOut(
                  node,
                  2000,
                  function(e) {node.style.display = 'none';})
```

The effects currently provided by Dojo are:

- fadeOut(): fades the opacity of the element from 100 to 0
- fadeIn(): fades the opacity of the element from 0 to 100
- fadeHide(): fadeOut, but sets the .display property of the element to 'none' at the end
- fadeShow(): fadeIn, but first guarantees that the item is being displayed
- slideTo(): moves an element to a given position on the screen
- slideBy(): moves an element a certain distance on the screen
- colorFadeIn(): uses a provided color as the starting point, fades to the original background color of the element. This effect is also called highlight (is officially aliased that way)
- colorFadeOut(): fades from the original background color of the element to a provided color
- wipeIn(): sets the height of the element to 0, then grows it to its original size
- wipeOut(): sets the height of the element to its original size, then shrinks it to 0
- explode(): takes a from node and a to node, expands the size of the from node until it matches the to node
- explodeFromBox(): takes a set of four starting coordinates and an end node, grows the node from the starting coordinates to the end node position

- implode(): takes a from node and a to node, shrinks the from node to fill the to node
- implodeToBox(): takes a from node and a set of target coordinates, shrinks the from node to the shape specified by the coordinates

6.2 Conclusion

In this chapter, we've exposed you to the basic UI elements of three different Ajax libraries. While Script.aculo.us and Dojo seem to provide a lot of overlapping effects, as you can see, the style of use is drastically different between the two libraries. Which you end up choosing for your own projects is a matter of both taste and need; Dojo provides a lot more in terms of functionality than Script.aculo.us, and if you require those features, then it makes sense to work with Dojo's effects as well. However, if you are less interested in those advanced features and just want the effects, Script.aculo.us is a much lighter weight alternative. It has lower overhead from a bandwidth and a learning perspective.

In the next chapter, we'll use these libraries to re-implement our CRM application with whizzy UI features. We'll show server-side validation, notification techniques, progress indicators, and more. Additionally, we'll talk about what NOT to do with Ajax. There are some big anti-patterns waiting for you out there; we'll give you the heads up on how to keep your app clean.

Chapter 7

Ajax UI, Part II

In the last chapter, we started to look at using some of the available Ajax JavaScript libraries to drive the user interface in a browser. Understanding how these libraries help you more efficiently control the UI is Step 1. Step 2 is understanding what you should do with your newfound tools.

This chapter will present some of the standard techniques for utilizing Ajax on the UI. We'll talk through validation, notification and data management strategies that have proven themselves to increase the utility AND usability of web applications. Later, we'll talk about some antipatterns, too, the things you should avoid and the tests you should apply when Ajaxifying your application. This chapter isn't an exhaustive treatise. Our intent is to give you a set of foundational tools for deciding how to (and when not to) proceed.

7.1 Some Standard Usages

Let's look at several common applications of Ajax using the libraries we talked about in the previous chapter: Prototype, Script.aculo.us and Dojo.

Server-side Validation

Web applications are faced with a variety of standard problems. Validation is one that has spawned an infinite array of potential solutions. We have learned over time that there is one universal delineation to be taken into account: server-side vs. client-side. Or so we thought. Client-side validation is handy for our users because they get "instant" feedback about the correctness of their data entry without having to

wait for the whole page to refresh. Client-side validation is largely useless to the application developer, however, since it is trivial for a user to circumvent client-side JavaScript. Heck, users can ignore our rendered HTML entirely and craft requests to our system using Telnet. Therefore, server-side validation is always mandatory. Client-side validation is a usability enhancement for our users.

Ajax allows us to combine the two techniques for greater usability. The problem with client-side techniques is that the validation rule itself has to be portable to the browser. This means you can execute regular expression matches, required field checking, and even small-scale data comparisons (for example, is the state abbreviation one of the standard 50 two-letter abbreviations). You can't, however, validate the inputs against your database, or against any server-side resident data or rules. With Ajax, we get the benefits of client-side validation ("instant" feedback without a page refresh) but the power of server-side validation (comparison against server-resident data or rules).

This means that we can create web applications with full validation the way we have historically been able to do only in *fat client* applications. We can use a full-fledged rules engine, for example, for validating individual data fields. But keep in mind that we are still required to revalidate the data on the final submission, because users can bypass an Ajaxified web application just as easily as a standard one, which means the final POST must be checked from top to bottom. So, this pattern gives us more powerful client-side usability, but does not solve the underlying security problem at all.

We're going to modify the CRM application from the earlier chapters with our new Ajax patterns. For this validation example, we have to start by preparing the UI itself. Here is the original HTML for rendering the Customer Name and Address fields for input:

File 13

```
<tr>
    <th>Customer Name:</th>
    <td><input type="text" name="name"/></td>
</tr>
<tr>
    <th>Address:</th>
    <td><input type="text" name="address"/></td>
</tr>
```

It includes a label and an input field for each data value. It doesn't have any reasonable place to put an error message when validation fails. Error messages should be conveniently colocated with the input fields they describe, so we'll add a new <*span*> element directly beside

Validation Error Messages

In addition to displaying error messages next to the fields they are associated with, it is also common (and, dare we say, appropriate) to include a general message area that provides a summary of all error messages. Adding one is left as an exercise to the reader.

the input fields. The <*span*>s will be marked with a specific CSS class so that we can control their look (in this case, we'll just style the text red). Plus, we'll update the input fields to each have a unique ID, which we can use to extract the values at runtime, and the new <*span*>s also have IDs so we can fill them in with new innerHTML after validation.

Secondly, we'll need to hook our validation code up to an event on the input fields. The standard event to hook for this purpose is the onblur event. This event fires whenever the user changes focus away from the field, whether by clicking elsewhere or tabbing away from it. We'll call a JavaScript method from the onblur event that will perform the validation. The method is called validateField(), and we'll examine it more in a minute. For now, know that the function takes four parameters:

- field id: the id of the input field being validated
- required: whether or not this field is a required field
- validation: the validation rule to execute on the data
- update: the id of the field used to display the error message

The new version of the UI elements looks like this:

File 8

```
Line 1   <tr>
-            <th>Customer Name:</th>
-            <td>
-              <input type="text" id="name" name="name"
5                     onblur="validateField('name', 'required', 'name', 'nameError')"/>
-            </td>
-            <td colspan="2">
-              <span style="border-bottom: solid 1px red;
-                           color: red;" id="nameError">
10             </span>
-            </td>
-        </tr>
-        <tr>
-            <th>Address:</th>
15          <td>
-             <input type="text" id="address" name="address"
```

```
                onblur="validateField('address', 'required', 'address', 'addressError')"/>
      </td>
      <td colspan="2">
        <span style="border-bottom: solid 1px red;
                     color: red;" id="addressError">
        </span>
      </td>
  </tr>
```

Thirdly, we need to write the method that calls the validation on the server. Its job is to launch an asynchronous request, passing in enough information to validate the field, and then update a named display element with the error message, if any. Our validateField() method first constructs a parameter list to append to the validation URL using the input parameters to the method. It then uses the Prototype library's Ajax.Updater to fire the request and fill in the display field with any error message generated.

File 8

```
Line 1  function validateField(fieldname, required, validation, update) {
        var params = "type=" + validation    +
                     "&required=" + required +
                     "&value=" + $F(fieldname);

        new Ajax.Updater(update, validationUrl, {
          asynchronous: true,
          method: "get",
          parameters: params
        });
    }
```

Finally, we need to create a server-based validation engine. You could invoke any standard platform validation engine you desire: Struts validation, dyna-validation, Spring's Validator, the ASP.NET validation rules, a rules engine, whatever. Here, we've written a custom Servlet that takes a field's value and the rules to invoke (required or not, plus specific rule) and either returns an empty String (meaning it succeeded) or an error message (for failure). Clearly, we'd add things such as i18n and SQL-injection protection if this were to be released to the public. Here is that servlet, in its entirety:

File 6

```
Line 1  package ajaxian.book.crm.servlet;

        import javax.servlet.http.HttpServlet;
        import javax.servlet.http.HttpServletRequest;
        import javax.servlet.http.HttpServletResponse;
        import javax.servlet.ServletConfig;
        import java.io.PrintWriter;
        import java.io.IOException;

        public class ValidationServlet extends HttpServlet {
            public void doGet(HttpServletRequest request,
                              HttpServletResponse response)
                throws IOException {
```

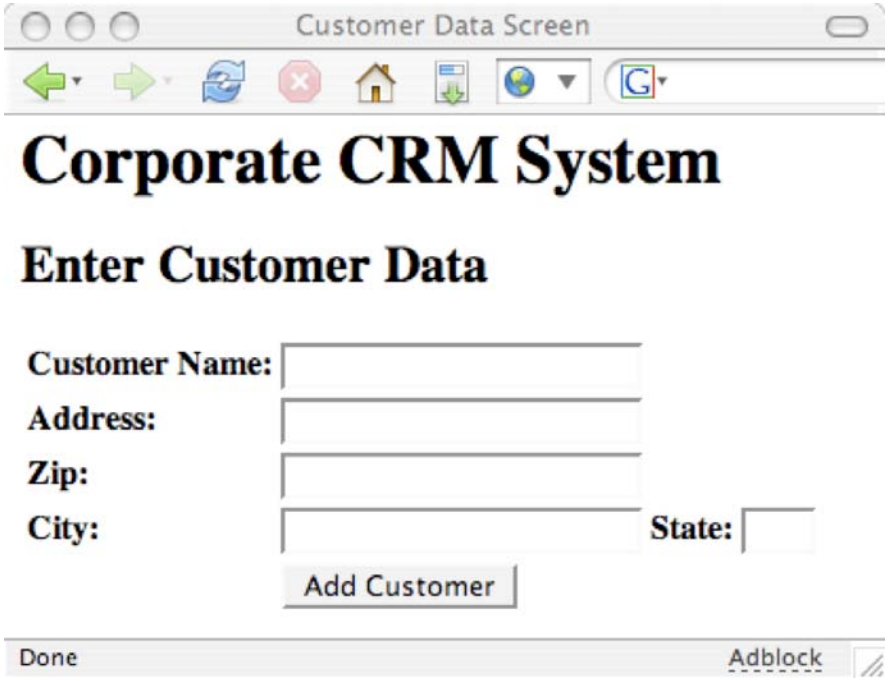

Figure 7.1: Form waiting for input

```
15          response.setContentType("text/html");
            PrintWriter out = response.getWriter();
            System.out.println(request);
            String required = request.getParameter("required");
            String type = request.getParameter("type");
20          String value = request.getParameter("value");
            String message = "";
            if(required.equals("required")) message += validateRequired(value);
            out.println(message);
        }
25
        private String validateRequired(String input) {
            if (null==input || 0==input.length()) return "Field required";
            return "";
        }
30  }
```

When the user first sees the page, as shown in Figure 7.1 , it looks like any standard HTML form, waiting for input.

As the user tabs through the fields, leaving data that breaks the rules,

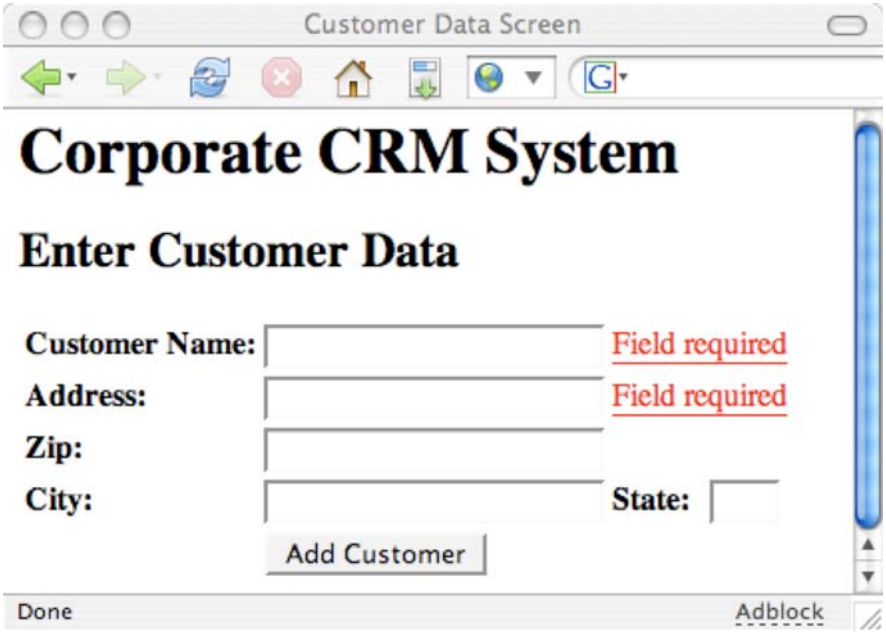

Figure 7.2: Form displaying validation errors

the page updates without a refresh, giving the user instant feedback, as shown in Figure 7.2 .

Request Notification

The asynchronous server-side validation we just created works well. The user gets a pretty big benefit without too much of a cost. We do have one problem, though. The user is firing server-side events via a non-standard mechanism. Rarely does a web application user expect the TAB key to establish a connection back to the server. Without that expectation, they might be very surprised to find that bandwidth is consumed at this point, and even more surprised when, a half second later, the UI suddenly pops up a block of red text next to the field they just left. If you take into account the expected occurrence of network latency, and suddenly you have the scenario of a user getting all the way to the bottom of a form before error messages start filling in at the top. How bad would it be if the error messages popped up in an area of

the screen the user has already scrolled past? Fairly inconvenient, at the least.

The answer is to include a feedback mechanism that alerts the user that a request is in progress. Browsers typically accomplish this through a spinning/jumping/waving graphic in upper right corner that only animates while a request is being processed. Ajax techniques can't take advantage of this UI convention, though, for two reasons: it is difficult-to-impossible to control the browser's request icon, and it can only alert you to the status of a single request at a time. With Ajax, and a technique like the validation described above, there can be multiple concurrent requests being processed.

The standard solution is to show an animated graphic that indicates a request in process, but show it inline, wherever the results of the request will be displayed. If the graphic pops up immediately, the user knows right away that something is happening and where to look for the results. Multiple graphics can be shown simultaneously by embedding them in multiple containers in the DOM. The current standard is to use an animated GIF image, which is quick to load and implies activity without having to actually poll the current status of the request, as shown in Figure 7.3, on the next page.

First, we're going to add some <*span*>s to the page to hold our progress indicators. In this case, the image as an animated GIF called progress.gif, which is just a spinning wheel. We'll add them between the input fields and the associated error message containers; this will place the notification GIF approximately where the error message will appear, so the eye is drawn to the appropriate place. We'll go ahead and make a hard link to the image, rather than loading it dynamically with JavaScript, though either would be acceptable. The browser will natively attempt to cache the image for the first container, and all subsequent containers will use the cached GIF, preventing needless roundtrips to the server for the same file. We'll simply place the image in a <*span*> whose display: style is set to none. When we want to notify the user, we toggle the <*span*>. When the request is complete, we toggle it again.

File 7

```
Line 1   <tr>
-            <th>Customer Name:</th>
-            <td>
-              <input type="text" id="name" name="name"
5                     onblur="validateField('name', 'required', 'name', 'nameError')"/>
-              <span id="nameProgress"
-                    style="display:none;"><img src="../progress.gif"/></span>
-            </td>
```

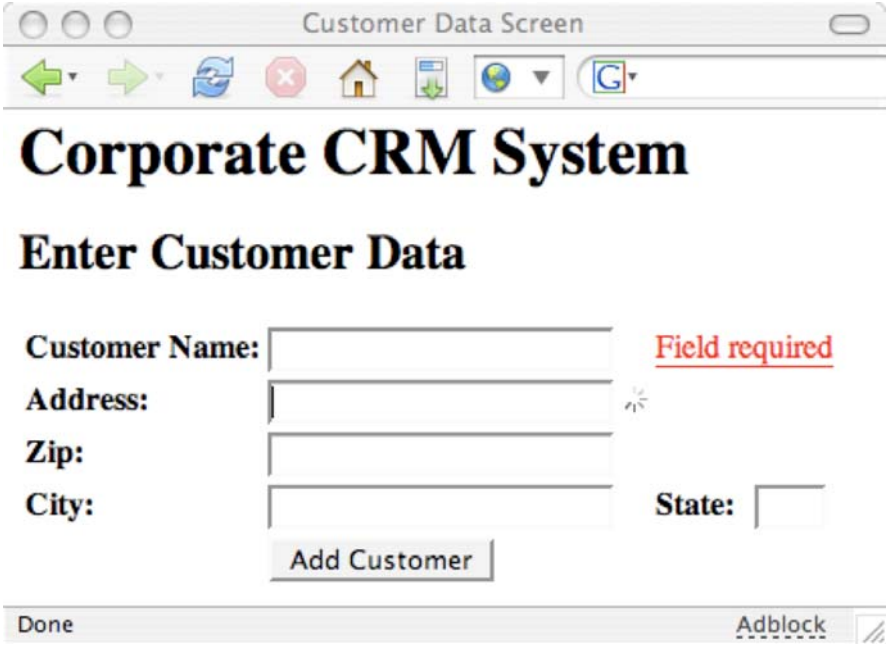

Figure 7.3: Form processing validation request

```
      <td colspan="2">
        <span style="border-bottom: solid 1px red; color: red;"
              id="nameError">
        </span>
      </td>
  </tr>
  <tr>
      <th>Address:</th>
      <td>
        <input type="text" id="address" name="address"
               onblur="validateField('address', 'required', 'address', 'addressError')"/>
        <span id="addressProgress"
              style="display:none;"><img src="../progress.gif"/>
        </span>
      </td>
      <td colspan="2">
        <span style="border-bottom: solid 1px red; color: red;" id="addressError">
        </span>
      </td>
  </tr>
```

Secondly, we have to update our request generating code. In the last example, we use the Prototype library's Ajax.Updater object to perform our round trip. We'll extend that example here. The options collec-

tion contains four event hooks: onLoading, onLoaded, onInteractive and onComplete, each corresponding to one of the four readystate values. Prototype simply implements the onreadystatechange hook, then publishes the specific events as those values arrive. We'll trap the onLoading and onComplete events, to allow us to show the image when the request begins and hide it once a response has been received. The values for the two events need to be function calls. Instead of simply calling Element.show() and Element.hide() directly, we'll wrap them in anonymous functions. If you don't do this, the onLoading call never completes, the validation result is never received, onComplete is never called and the little spinning wheel becomes the only interesting thing about the page.

File 7
```
function validateField(fieldname, required, validation, update) {
   var params = "type=" + validation +
                "&required=" + required +
                "&value=" + $F(fieldname);
   new Ajax.Updater(update, validationUrl, {
      asynchronous: true,
      method: "get",
      parameters: params,
      onLoading:  function(request) {Element.show(fieldname + 'Progress');},
      onComplete: function(request) {Element.hide(fieldname + 'Progress');}
   });
}
```

Update Notification

Web surfers are largely trained to believe that something loaded on a page is static. They understand that, in order to update the contents of a page, the page must be reloaded. The only cognitive exception to this rule is animations. The web surfing population understands that certain graphics are not static, but in fact loops of animation. These are expected to repeat the same set of information over time, though, and are not actually "dynamic" in any data-centric meaning of the term.

Ajax is all about breaking this particular expectation. That is, in fact, the core idea of Ajax: break free from the bonds of static information. But it literally goes against the foundation of most users' understanding of how the web works. Which means that we have to take special pains to ensure that when we do break this convention, users don't miss it.

The primogenitor of this pattern is the famous Yellow Fade Technique, or YFT. Apparently created (or at least named) by the crew at 37signals, the YFT is a simple trick. Simply choose a color (canonically and eponymously yellow), reset the background color of an element to this new color, then slowly transition it back to the original. The effect is

to highlight an area of the page as though with a Highlighter so as to draw the user's attention, but to have that intrusive effect disappear so as not to detract from the overall look and feel of the page.

To do this, you might write some code that manipulates the background-color style of an element. You might want to capture the original background-color so as to return the element to its original state at the end of the effect. You would be forced to deal with the fact that most browsers internally store colors in the form rgb(nnn, nnn, nnn). If you would prefer to work in hex notation (#ffffff) then you would have to convert them yourself. Likewise, you would have to come up with some strategy for moving from the original value to the target value for each color (red, green and blue) simultaneously to get a smooth transition.

Luckily, somebody else has already done that work for you. Previously, we've used the Prototype library to do server-side validation and progress notification. We're now going to layer the Script.aculo.us library on top of that to get the Highlight effect.[1] We'll modify the sample application to use the YFT to alert you when the content of the City and State fields has been updated.

First, we don't have to change the HTML at all. We already have a container element with a unique ID that we can use for the highlight effect. It's the <*tr*> that holds the City and State fields. Its ID is rewrite.

File 9

```
Line 1   <tr id="rewrite">
     -       <th>City:</th>
     -       <td>
     -         <input id="city" type="text" name="city"/>
     5       </td>
     -       <th>State:</th>
     -       <td>
     -         <input id="state" type="text" name="state"
     -                size='3' maxlength='2'/>
    10       </td>
     -   </tr>
```

The second part is to update the getZipData() function to trigger the effect when the data has been loaded. Remember, XHR features the onreadystatechange event to alert your code when the status of the request has changed. In this case, though, Prototype offers us another option. As we saw in chapter XXX, the Prototype library provides two new events, onSuccess and onFailure, so that we can write error-aware asynchronous methods. Our current version of getZipData() already makes use of onFailure to alert the user if the request failed:

[1] http://script.aculo.us/

File 13

```
Line 1   function getZipData(zipCode) {
         new Ajax.Updater("rewrite", url, {
           asynchronous: true,
           method: "get",
         5 parameters: "zip=" + zipCode + "&type=html",
           onFailure: function(request) {
                   assignError(request.responseText);
           }
         });
        10 }
```

When the request fails, the assignError() function is called to display the message. We're now going to add a handler to the onSuccess method to perform the YFT. We use onSuccess instead of onComplete because onComplete will fire regardless of what's in the response. This would lead us to highlight city and state even if their data doesn't update. Instead, we use onSuccess, which only fires if the request returned data that ends up in the display fields.

File 23

```
Line 1   function getZipData(zipCode) {
         new Ajax.Updater("rewrite", url, {
           asynchronous: true,
           method: "get",
         5 parameters: "zip=" + zipCode + "&type=html",
           onSuccess: function(request) {
              new Effect.Highlight('rewrite');
           },
           onFailure: function(request) {
        10         assignError(request.responseText);
           }
         });
         }
```

The effect of this new handler is that the row containing City and State will go yellow whenever the request succeeds, then fade back to white over a one second period. Bear in mind, as we learned in the previous chapter, you can affect the behavior of the transition by submitting options to the call. For example, you can change the transition to go from cornflower blue to white over three seconds with a linear transition by changing the call to:

```
Line 1   new Effect.Highlight('rewrite',
                        { startcolor: '#92A4E2',
                          duration: 3.0,
                          transition: Effect.Transitions.linear } );
```

You can also choose the end transition color (endcolor) and the final color to use after the fade (restorecolor) if you need to.

Auto Update

One of those things that often sets traditional thick clients apart from thin clients is the ability to quickly react to what the user is doing. For example, there are lots of locally installed applications that can react to what a user is typing, and make intelligent guesses about how to complete the word(s) for the user. Google (once again) showed that the same thing could be accomplished on the web with Google Suggest. This feature has come to be known as *autocomplete*.

Scriptaculous provides an amazingly simple-to-use version called the AutoCompleter. It watches an input field and sends a post parameter of the same name to a registered server endpoint. The results are rendered in another container node, allowing the user to choose from the results. The whole affect can be achieved with the addition of one container, one line of JavaScript and a little simple CSS.

Let's add this feature to the sample CRM application. We'll prompt the user with potential zip code matches based on what they are typing in the zip field. As they type into the zip field, we'll compare that against the list of available zip codes, and return those that are potential matches (the ones that start with the characters entered so far).

Let's start with a servlet that implements the auto completion feature. Any reasonable production-quality version would use a database of zip codes, and the SQL "SELECT x WHERE zip LIKE 'y%'" notation to retrieve values. To keep it simple for the book, the servlet will instead just keep an array of zips as strings to compare against. Here's the servlet:

File 5

```
package ajaxian.book.crm.servlet;

import javax.servlet.http.HttpServlet;
import javax.servlet.http.HttpServletRequest;
import javax.servlet.http.HttpServletResponse;
import javax.servlet.ServletConfig;
import java.io.PrintWriter;
import java.io.IOException;
import java.util.Iterator;
import java.util.ArrayList;

public class AutoCompleteServlet extends HttpServlet {
    public void doPost(HttpServletRequest request,
                       HttpServletResponse response)
        throws IOException {
            System.out.println(request);
         String[] zips = new String[] {
            "10010", "11035", "27707", "31000", "32230", "34434",
            "45555", "46666", "46785", "46699", "49999", "53711", "53703" };
         ArrayList results = new ArrayList();
```

```
            String val = request.getParameter("zip");
            for(int i=0;i<zips.length;i++) {
               if(zips[i].startsWith(val)) results.add(zips[i]);
            }
            String message = "<ul>";
            Iterator iter = results.iterator();
            while(iter.hasNext()) {
               message += "<li>" + (String)iter.next() + "</li>";
            }
            message += "</ul>";

            response.setContentType("text/html");
                 PrintWriter out = response.getWriter();

           out.println(message);
       }
}
```

Next, we'll have to add the Ajax.AutoCompleter and a container <*div*> to hold the responses we get from the server. The entire update to the UI is shown here:

File 22

```
<tr>
    <th>Zip:</th>
    <td><input autocomplete="off" onblur="getZipData(this.value)" type="text" name="zip" id="zi
    <div class="auto_complete" id="zip_values"></div></td>
    <script type="text/javascript">new Ajax.Autocompleter('zip', 'zip_values',
                    '/ajaxian-book-crm/autoComplete', {})</script>
    <td id="zipError" style="color: red"></td>
</tr>
```

First, we had to make a minor change to the zip input field itself. We added the autocomplete="off" attribute, which prevents the browser from attempting to fill in the value itself. This would pre-empt our JavaScript version, and nullify the whole exercise, so we'll disable it. Next, we have to add a container to hold the results; that's the <*div*> named "zip_values". Finally, we add a <*script*> block to invoke the Ajax.AutoCompleter. The first parameter is the id of the input field to be auto-completed, the second is the id of the container to display the results, the third is the server endpoint to send the request to, and the final parameter is a collection of options.

In our case, we're not using any of the optional parameters since the defaults work just fine for this purpose. However, the options you have to customize the behavior of the AutoCompleter are:

- paramName: a name to use for the value sent to the server (defaults to the name of the target input field)
- frequency: how often to check for changes to the input field and send the request (defaults to 0.4 seconds)

- minChars: how many characters the user has to enter before the first request is sent (defaults to 1)
- afterUpdateElement: a callback hook for after the values are returned and set into the target container

Scriptaculous also provides another object, AutoCompleter.Local which uses a locally cached list of values instead of making roundtrips to the server. This would increase speed at the expense of stale data.

To finish the example, we just have to make the results look pretty. Without any style help, the results will be displayed in a transparent <*div*> as a series of bulleted list items, without keyboard navigation. Clicking on one with the mouse would be the only way to select and entry from the list. We are using the styles provided by Scriptaculous to make our list entries navigable and pretty, as shown below:

File 22

```
<style>
          div.auto_complete {
            width: 350px;
            background: #fff;
          }
          div.auto_complete ul {
            border:1px solid #888;
            margin:0;
            padding:0;
            width:100%;
            list-style-type:none;
          }
          div.auto_complete ul li {
            margin:0;
            padding:3px;
          }
          div.auto_complete ul li.selected {
            background-color: #ffb;
          }
          div.auto_complete ul strong.highlight {
            color: #800;
            margin:0;
            padding:0;
          }
</style>
```

The final result is shown in Figure 7.4, on the following page. Notice how the effect is like a drop-down box. The <*div*> has a narrow black border, the individual items are displayed without list bullets, and as you key up and down the list, the items highlight with (in this case) a pale yellow. Pressing enter while an item is highlighted, or clicking one with the mouse, causes that value to be set into the input field.

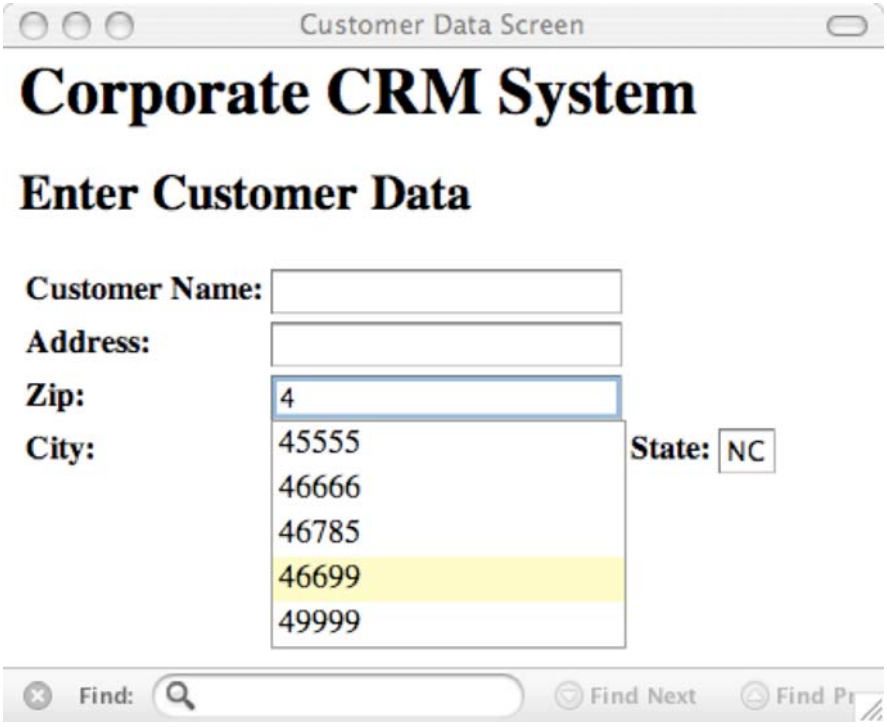

Figure 7.4: Auto-complete in action

7.2 It Isn't All Just Wine and Roses...

Ajax is fantastic. It opens the web to a whole new way of developing and delivering applications to your users. Largely, it changes the experience of using a web app from *reading* to *using*. As long-time instructors and trainers, we know first-hand the value of interaction in keeping students engaged and happy. The same phenomenon applies to applications, as well. If your application is passive, and makes your users passive consumers, then the application will not capture your users' attention. An interactive version, however, has the power to excite.

Even though Ajax has this power to change the web so radically, it behooves us all as developers to remember why the web enjoys such broad acceptance. It is based around certain standards (technical and visual) that have allowed users of all stripes to take advantage of ser-

vices provided there. Those standards, some written and some simply understood, are vital to the success of all applications on the web, whether or not they use Ajax.

The key to a successful Ajaxification is to not ignore important conventions. There are certain laws of the land that made the web so popular and accessible, in ways that other applications and technologies never were. As you add this new technology into your application, think both tactically and strategically. Ask yourself the following questions:

- "Is what I'm adding increasing the usability of my application, or the length of my resume?"
- "Does it break an ingrained habit of my users?"
- "Is the value worth the cognitive dissonance such a break will cause for my users?"

Tactically, the change might increase the usability of this single page, but strategically, reduce the usability of the application as a whole.

We'll walk through some of the biggest anti-patterns to watch out for. This list is not exhaustive. When in doubt about something you are working on, check it against our smell-test questions above. And keep in mind that the key is usability and fun: if it increases both, then do it!

Watch That Back Button!

Two things set the World Wide Web apart from everything that came before it: the back button, and the bookmark. Applications historically were guided tours. Users were encouraged to follow certain paths through the information provided. At best, users might be able to search for a specific item or screen and navigate directly to it. If they moved on, the only way to get back was to run the search again. And even this was a rare enough feature for an application. Consider Quicken circa 1998, or those multimedia encyclopedias we all bought back in '96. You had tables of contents, and search capabilities, but no notion of the history of your actions.

The back button isn't just a button; its a symbol of freedom. It means that you are free from the shackles of the guided tour. You forge your own path through the information at your fingertips, and can retrace your steps at your leisure. You become the master of the application, instead of the other way around. Don't believe me? Go into your

browser and turn off the navigation bar and see how long you go before having to turn it back on again.

Bearing this in mind, now picture how the back button actually works. The default behavior for a browser is to cache pages as they are downloaded. Clearly, this feature can be overridden at either the browser or server level, but the default is to create a local cache. Only the original state of a page as downloaded from the server is cached. If the DOM is modified in any way by client-side JavaScript, those changes are not reflected in the cache at all. Conversely, if the page was NOT cached, then the back button merely sends a new request to the server to request the page, which will return the page in its original state anyway. The practical upshot of all this is that all your Ajax goodness is lost when the user navigates away from your page and back again.

Its even worse than it looks at first glance, as well. If the page has elements whose value is determined at parse-time, then those values will be cached along with the rest of the page. Clicking the back button will normally result in a load from cache where possible; if the page was cached, the elements will contain possibly outdated values since the server-side parse never takes place a second time. At that point, only if the user manually refreshes the page will the new values appear.

It becomes incumbent on the designer of the application to distinguish between information retrieval and navigation. When a user wants to proceed to a new topic area, they generally want a history of where they were previously. The back button is the instant access to that history; navigating to a new subject area via an Ajaxian in-page replacement nullifies the ability of the back button to perform its appointed duties. Take, for example, the very common practice of online newspapers splitting its articles up over multiple pages. In standard HTML, the current page ends with a link to Next Page>>. Clicking that reloads the browser and shows page 2 of the article. At the bottom are now links to <<Previous Page and Next Page>>. Users can use either the link or the back button to navigate backwards. Since the pages are part of a unified whole, and the user is already trained to use the Next Page>> link for forward navigation, it wouldn't bee too much of a stretch to do an Ajax version where the pages are loaded into a <*div*> on the fly. Users would use the built-in navigation as before; clicking the back button would take them away from the article entirely, back to the table of contents. This seems fairly natural.

Alternatively, imagine the same online newspaper site, but with a table

of contents whose links to articles operate in Ajax fashion. Clicking on the title of an article replaces the table of contents with the text of the article. Navigating forward and back in the article happens via Ajax as well. When the user clicks the provided Next and Previous buttons, new pages are loaded into the same <*div*>. What happens if the user clicks the back button now? They don't end up back at the table of contents; instead, they end up at whatever web site they were at before coming to the newspaper site at all. This is because the table of contents was forced into the same page context as the articles it listed. By doing so, you have essentially eliminated the history of a topic transition for your user (toc → article) that they would normally expect to be maintained for them.

It is hard to pin down the exact point at which Ajax breaks this rule. But it is really easy to spot it after you have done it. Just use your application a few times. Whenever you find yourself annoyed because you can't retrace your steps, you have probably found an instance of this anti-pattern.

Bookmarking Makes the Web

Bookmarking is the kissing cousin of the back button. It is a user-controlled meta-history of their browsing exploits. Bookmarking the index page (the welcome mat) is less useful now than it was in the past. With Google as our shared bookmarks, most people don't bother bookmarking the index page anymore. Its just as easy to run to Google, type in the page name, and click the resulting link (or even the *I'm feeling lucky* button, which we almost never are). Instead, we use bookmarks for *deep linking*. This means capturing the state of the application or site at some point after you have begun interacting with it. Perhaps the results of a search at Amazon, or the report of your current holdings at your financial institution, or some particular article at the New York Times.

Deep linking means that users have the complete ability to pause and return to your application. If state is maintained (cookies, long term sessions, backend storage, whatever) and users can specify where in the application flow to resume their work, then they are not chained to your timetable. We often find ourselves in the middle of something on an application but forced to take a call, or run to a meeting. We want to know that we can pick up right where we left off at some later time.

So we bookmark the page. If we come back, open the bookmark, and end up back at the index page instead, we're displeased.

When a user arrives at an Ajaxified page, the URL that appears in the address bar is whatever they typed in or clicked on to get there. When a bookmark is added to a browser, it makes a copy of the current address in the address bar. If the page has allowed the user to progress through tens or hundreds of interactions, the URL in the address bar is exactly the same as it was for the initial request. A user who navigates to the bookmark will always end up at the original state of the page; Ajax-based changes will be long forgotten.

Once again, we are faced with the distinction between a major topic area of the application vs. a minor shift in focus. Users will accept certain limitations on their bookmarking ability; for example, most people don't expect to be able to bookmark a page halfway through the checkout wizard at an ecommerce site. Clearly, users have come to learn the difference between static pages and stateful processes which can't be snapshotted. Developers now have to come to the same realization: what transitions can I encapsulate in a non-bookmarkable process, and what requires page transitions in order to allow pause-and-resume behavior?

GET is for Getting, POST is for Doing

In the world of HTTP, browsers communicate with servers using (typically) either GET or POST requests. A GET request is generated whenever you click on a hyperlink; the idea is that it *gets* the next page. A POST request is sent when you hit the submit button on an HTML form. It *posts* the data from that form back to the application for processing.

In May of 2005, the team that created Basecamp (and Ruby on Rails) learned this really valuable lesson: GET is for getting things, POST is for doing things. The HTTP specification is pretty specific on this topic. GETs are for retrieving data. POSTs are for interacting with the server in a way that might change server state. When you avoid the recommendations of a specification, bad things can—and often do—happen. Their public tussle with this issue serves as a cautionary tale for the rest of us: if these kinds of issues can affect the best and brightest, we need to be extra careful in our own applications to avoid similar problems.

Basecamp's problem was that, at the time, the default method for creating links back to the server with Rails was a GET. It didn't matter what the link was doing: redirecting to a new page, reading a record, or deleting a record. Then, Google released the Google Accelerator. The Google Accelerator installs in your browser and redirects requests through Google's servers. If Google has already cached the page, you'll be rewarded with the previously cached version, thus speeding up your access time. If the page has not been cached, then the request is forwarded on as normal. Google Accelerator then walks all the links off of the returned page, thus caching it and all of its sub pages.

For an application whose controls are all provided as simple GET-method links, Google Accelerator becomes the most efficient destructive force imaginable. Think of it as the Terminator of web apps. It is single-minded: fire a request to every link on the page. It is efficient. And it absolutely will not stop until your app is dead.

37signals didn't realize there was a problem until data started disappearing from the Basecamp database. As users began reporting that their data was mysteriously missing, the team finally realized that the common thread was Google Accelerator. Normally, such a thing wouldn't be a terrible problem. After all, Google's indexing worms follow essentially the same path; find a page, navigate to all the link endpoints, cache, continue. But with Google Accelerator, the worm finally has access to information it has never had before: your username and password. Navigate to your Basecamp account, for example, and log in. The Accelerator can now follow all the links on your private page. It then clicks everything it can, as fast as possible. And some of those links are labeled *Delete This Item*.

The solution was to change their framework, Rails, to create POST-method links for update methods. They did this by creating a second view helper in addition to link_to() that creates a <*form*> element to surround a button. The parameters are embedded as hidden <*input*>s. The <*form*> is set to POST as its method. Now, your update-related links don't fall prey to the Accelerator.

When you Ajaxify an application, the temptation to write pages this way is strong. You present your user with a list of items. You want them to be able to add new ones or delete existing ones from the page without a refresh. So you add a link to the bottom, New Record. Embedded in each item on the list is a link called Delete. You use a simple GET with an URL like this: http://www.mydomain.com/my/app/delete?recId=545. What

could be easier? Of course, the Accelerator will knock on your door. "Sarah Connor?" it will ask. And that will be the end of that.

Tell People When Updates are Happening

When browsing a Web 1.0 application, pay careful attention to the feedback you get from the application, the browser, and your OS. For example, when you click on a link to another page and the data has started to render (but slowly), what feedback are you getting? The refresh icon in the upper right corner of your browser begins to sping or jump or change colors. On the Mac, the cursor turns into the Rainbow Wheel of Doom and you can't click on anything in the browser window (though the browser's menus are usually still accessible). That's because the navigation operation is synchronous: you are forced to wait until it has completed before you can use the contents of the window. Or when you choose File→Print from the menu. The dialog box often takes a second or two to appear as it scans your network for configured printers. While this is happening, your cursor might turn into an hourglass, and you won't be able to click on anything in the browser window OR on the menus.

Synchronous operations come with their own feedback. If it is related to requesting new information, the browser tells you via the refresh icon. You get feedback in the form of not being able to click on resources. Even your cursor changes to tell you "Quit clicking that." You know that the browser is attempting to do work on your behalf. Now, enter Ajax. The *asynchronous* part makes everything different. When you fire an asynchronous request back to the server, there is nothing that the browser will do for you automatically that provides feedback to the user that something is going on. It will quietly and invisibly wait for the response to come back, then put it wherever your JavaScript tell it to go. Suddenly, as if by magic, the rendered HTML is updated. Voila! Some previously hidden <*div*> pops into view, filled with useful but surprising information! Unfortunately, your user has already scrolled past that part of the page, and misses all the fun.

It is up to you to provide adequate warning to your user that some activity is being performed on their behalf. Because they are able to continue to work with the page and the browser after firing an asynchronous call, you have have to provide visual cues to them to let them know that something is on the way. Earlier in this chapter, we showed you a technique for popping up a notification animation. Often, this

technique is enough. But sometimes, you'll have to do more. Perhaps change the cursor, perhaps show a full progress bar. Regardless of the specific technique, you should always provide a mechanism to warn your users that clicking that link, or pressing that button, or doing whatever it is, has now fired a request and the browser is waiting for a response.

Don't Reinvent the Wheel

We've grown accustomed to certain UI conventions. Modern operating systems and their windowing toolkits all offer us certain abstractions that have settled in our conciousness. We know what a *window* is, for example. Even my parents know that when they see a box on the screen with an outset border, a header at the top and some buttons in upper left or right corners, that that thing can be dragged around on the screen and it can be closed. We know what a button looks like and that the appropriate thing to do is click on it, once, to press it. We've been trained that text along the top edge of a window are probably menus, and that if we hover the mouse over them or click on them, they are likely to spawn little submenus. I've actually run this experiment with my family. They are Microsoft Windows users. If I put them in front of a Mac, they know how those conventions work even though the actual graphical look is entirely different. They have no idea what the Dock is for, but the common abstractions are plain and clear. Likewise, when they sit at a Gnome or KDE desktop on my Linux box, everything is fairly straightforward.

The web has taught us some additional standards. Now, we agree that text along the top or left edges may be a menu, and that hovering the mouse over a menu is preferable to having to click on it to get the submenu to appear. We know that words, underlined and often blue, are *hyperlinks* that will navigate us to a new page. Square gray boxes next to words are check boxes, which can be checked and unchecked individually, while groups of gray circles are *radio buttons*, and clicking on one affects the others. And when the cursor turns into a little pointing hand, that means whatever we're hovering over is clickable.

These conventions enable a common computing experience. They are the very thing that allows users not to have to RTFM every time they encounter a new application. They allow us to surf the web, which is really just the accumulation of a billion applications designed by a billion monkeys. Without those conventions, every new web page would

be a new cognitive experience; we'd have to take a day to read the help before being able to check the Eagle's score. The web would be useless.

So don't be tempted to think you are smarter than the collective. As programmers and designers, we often suffer from a certain hubris that says "I can be better than the lowest common denominator." The problem isn't believing that belief. The problem is mistaking "common" for "lowest common." Just because everybody is doing it doesn't make it bad. That kind of logic is just counterintuitive enough to appeal to my old highschool self, whose fascination with The Cure and Metallica was fed by the belief that Phil Collins couldn't possibly be any good because so darn many people listened to his music.

For example, Ajax enables us to create portal sites the right way. (See **??**, on page ?? for further treatment of portals.) Basically, a portal is a web site that displays multiple disparate content areas on a single page. There could be local weather, last five email messages, who is currently logged into the site, RSS feeds, etc. Each content area is self-contained, they can be added and removed individually, often minimized, closed entirely, and dragged around and repositioned. That reminds us of something we were just thinking about...hmmm, what was it...oh, right, a WINDOW! That's it! A content area in a portal is just like a window! And we currently have a convention for drawing a window so that the user knows what to do with it. Which means that a really good portal site should look something like Figure 7.5, on the following page.

The individual portlets clearly are closeable and minimizable, and it shouldn't surprise us at all to find out that they are draggable. The temptation can be strong to reinvent all of this—rounded windows without obvious title bars, little dots in the lower left corner to click on to close the window, etc. While we're fans of avant-garde design, we don't like struggling with an interface to figure out how it works. We like being surprised by an interface even less. Stick with what works.

Likewise, launching asynchronous calls to the server based on non-standard interactions with a page will be disconcerting to your users. Running your mouse over an obvious menu at the top of the screen and causing a menu to pop up is fine, even if it involves (quick) round trips. Having menus pop up as you mouse over random words in a paragraph would be alarming. Causing data to refresh when users click on buttons is expected. Causing data to refresh when users click on links might be surprising. And for crying out loud, think very very carefully before you start shaking, puffing and squishing elements on

Figure 7.5: A Well-Designed Portal

screen. Ask yourself if the effect is something the users will understand in context, or if they will just be surprised by it.

7.3 Conclusion

In this chapter, we've talked about some common patterns for making effective use of Ajax in the UI. For the most part, what we've shown is how to use Ajax to make web pages respond more like the rest of the user interfaces that our customers have grown accustomed to. Alerting our user to changes in data, or that background processing is ongoing, or that they have committed errors in their data entry are all just ways of increasing the responsiveness of the application while keeping with

standard conventions. Techniques like auto-updating text boxes allow customers to use our applications more efficiently. Sorting data, and drag and drop capabilities, make the UI more like the standard "thick" UI components of our desktop systems.

As with anything, though, the trick is knowing when *not* to do it. The second half of our chapter was all about keeping ourselves focused on the most important point: usability. When these techniques make it easier for our users to accomplish a task, then the technique is successful. When they get in the way, when they cause our users to have to think about what they are doing, then we should reevaluate our decision. And above all, never surprise the user.

Chapter 8

Server-side Framework Integration

Over the next four chapters, we're going to introduce four web application development frameworks and examine the server-side integration techniques they use for incorporating Ajax. This kind of integration can be very valuable for a development team, allowing the members of the team to focus their efforts on one logical tier (the server) while simultaneously generating artifacts for two physical tiers (server and client).

To explore these frameworks, we're going to walk Hector's team through porting their CRM application to each framework. Along the way, we'll talk about the reasons why Hector might consider each port, and the relative strengths and challenges each choice presents. The four frameworks we'll examine are:

- PHP: Sajax is the first Ajax integration toolkit for PHP, and we'll examine it plus the newer Najax library.
- Ruby on Rails: Rails integrates very closely with Prototype and Script.aculo.us. In fact, the authors of those two frameworks are also Rails committers.
- Spring (Java): We'll look at the integration of the DWR framework with Spring for Java web applications.
- ASP.NET: we'll look at both Ajax.NET, an open source Ajax library, and the upcoming Atlas toolkit from Microsoft itself.

As we look at these four frameworks, and port Hector's application to each, bear in mind that we can't compare and contrast every aspect of the frameworks. This isn't a book about comparative web development; its a book about Ajax and how to use it to make applications today. We hope that these server-side chapters give you the introduction you need to evaluate how your current platforms are approaching Ajax, and how other frameworks you might not be familiar with are tackling the same problems with different strategies. If you want to read more about comparative web application development, we suggest XXX.

8.1 Different Strategies for Integration

There are several strategies that development teams can choose for integration Ajax with their framework. The choice largely depends on the philosophy of the framework team: should developers be using visual tools for assembling the application? Are web applications really about HTML? Should my server-side code be the primary metaphor for the entire application? In general, the strategies fall into three major categories: visual tool support, custom tag libraries (and helpers), and ORB-like remoting.

Tooling

Some server frameworks are built around the idea of using visual development tools for creating the view artifacts. Examples are the ASP.NET framework with its support in Visual Studio .NET, and the JSF toolkit for Java with support in several Java IDEs. The aim of such frameworks are to provide developers with drag-n-drop development. To be brief, the programmer uses components that are in charge of their own client-side rendering (like data tables and date pickers). These are assembled into a unified page. The components themselves are manipulated through a series of declarative properties that affect everything from their visual style to the component's lifecycle.

These frameworks are now integrating Ajax support through these declarative properties. In fact, ASP.NET has had such support for some time now. The programmer merely selects one of the properties (like, auto-updating for the data table) which enables in-page callbacks to the server to refresh data. The programmer might not even be aware that the result is, in fact, Ajax, just that the component now exhibits the desired behavior.

Later, in **??**, on page ??, we'll take a look at Ajax support in ASP.NET.

Helper Tags

A second approach to Ajax integration is custom tag libraries. Toolkits like AjaxAnywhere[1], and Ruby on Rails use custom tag libraries (or similar constructs) as an HTML-embedded stand in for server-side functionality. These tag libraries, sometimes referred to as helper tags, are parsed by the template engine of the given framework, which in turn generates client-side artifacts based on the attributes of the custom tag.

The result is a page that looks like HTML, but whose actual content is determined at parse time. The tags provide a layer of abstraction for integrating our server-side code into client-side templates. This can be a quite powerful ability, as it allows the developer to focus on a single artifact (the template) instead of jumping around between template and alternate code files.

We'll look at Ruby on Rails' Ajax integration in **??**, on page ??.

ORB-like Remoting

Our last category of Ajax integration with a server framework is to use ORB-like remoting to connect client-side JavaScript to existing server-side functionality. Using tools like JSON-RPC, DWR (for Java), Ajax.NET, or several PHP frameworks, a developer can write JavaScript code for the browser that can seemingly access the server-side domain model directly. The effect of these frameworks is that your existing domain code is now reusable across to the client tier, providing a seamless object model for the code on both tiers.

We'll examine ORB-like remoting in **??**, on page ??, as we discuss PHP and its Ajax integration. First, we'll look at the grand-daddy of all the PHP/Ajax integration projects, Sajax. Next, we'll compare to a newer player, Najax.

[1] http://www.ajaxian.com/archives/2005/09/ajaxanywhere_aj.html

Chapter 9

Ajax with PHP

PHP is the framework of choice for many web developers. It is free and open source, which means that it is widely adopted. For those who use it, they find that it is a pragmatic choice, one with a bustling community of users and developers. The community is so strong, in fact, that the library of available additions to the framework is quite large. If you find yourself wishing for a piece of functionality that isn't in the PHP core, make sure you have Googled around a bit before running off and implementing it yourself. Chances are, someone in the PHP community has done that work already.

This is true with the marriage of Ajax and PHP. There are several PHP-based frameworks out there, of various quality and richness of features. In fact, the first PHP frameworks were announced within days of the coinage of the term "Ajax". In this chapter, we will take a look at the most popular of these frameworks and will again rewrite Hector's CRM application. We'll finally focus on the server side of the application. Server-side framework integration means that we can utilize the same abstractions we have available on the server to implement a decidedly client-side set of features. The JavaScript frameworks we've talked about already (Dojo, script.aculo.us), etc., will be put on the back burner for now as we see what the server side can provide us.

9.1 The PHP Frameworks

Back in ??, on page ?? we discussed the fact that Ajax support has been announced in JavaScript frameworks left, right and center. Those frameworks were all written to run on the client, which in this case

means within a browser. Server-side development frameworks face the same pressures for innovation that client-side frameworks do.

We've long had support for client-side technologies in our server-side frameworks. From template-based view rendering technologies like JSP, ASP and RHTML, to server-side objects with self-rendering capabilities like ASP.NET and JSF components, these frameworks use a wide variety of methods to influence the client view. Now, they are adding the ability to generate JavaScript for the client to create Ajax effects and sometimes to hook up that JavaScript to server entities for data transfer. There are three major categories of Ajax integration support: visual tool support, tag libraries, and ORB-like remoting.

9.2 Working with Sajax

Let's return now to Hector and his CRM application. He's decided to move his team to an open source platform, namely PHP. He's convinced that his team will be able to get more leverage by using an integrated Ajax framework. This means the team can add these new effects and callbacks without leaving the confines of PHP. We'll first port the application to Sajax[1].

What is Sajax?

Sajax is one of the earliest Ajaxian web frameworks available, originally written for PHP. It is an open source project, and allows you to bind your web UI to server-side functions. It accomplishes this by exporting client-side JavaScript functions that invoke a Sajax bridge back to the server-side code that is actually executed, wrapping it all in an XHR request.

Sajax is an ORB-like remoting layer, which means that we will be able to first write the server side functions that we need (consisting of talking to the database, and returning the correct data back) and then bind our HTML UI directly to these functions. There will be no XMLHttpRequest() object to be found, and you may even be surprised with some of the JavaScript method calls that we can run, since we will not see them in the PHP code itself.

There is some tension in the development community surrounding this kind of object remoting strategy. Some developers are very keen on

[1] http://www.modernmethod.com/sajax/

Sajax Language Support

Sajax started with PHP and Coldfusion support, but now also supports:

- ASP
- Coldfusion
- Perl
- PHP
- Python
- Ruby

If you do not see your favorite language, chances are Sajax will soon support it.

using Web (XML) Services as the primary channel for communicating between different application tiers. Depending on who you talk to, this can mean anything from a REST-ful, loosely coupled XML-over-HTTP architecture all the way to a WSDL, SOAP and WS-* implementation. What they have in common is a move away from object (and method) orientation and to a message transport and service oriented architecture.

Object brokers, on the other hand, are entirely about enabling remote communications without disrupting the mental model of the object oriented developer. You can tie client-side methods to server-side objects as though they were physically colocated, thus giving the illusion that there are no network calls and roundtrips separating the different entities. While this is a powerful abstraction, it is still just an abstraction. There are, in fact, network roundtrips involved and, if you look at the messages that are sent, they look surprisingly just like the messages sent through service oriented frameworks.

Sajax chooses to expose its functionality through an object broker, thus placing a higher value on a standard experience for the developer across the physical application tiers. This might provide more efficiency at development time, but may come at the expense of efficiency at runtime. This is because any abstraction that hides the underlying remote nature of an architecture runs the risk of causing developers to forget

MySQLi and PEAR DB Interfaces

The service code uses the original mysql PHP library. If you are running later versions of PHP, you can use libraries such as mysqli and PEARDB.

- mysqli offers increased functionality such as support for prepared statements, and other performance related improvements.
- PEARDB is a DBI/JDBC like database abstraction layer. This allows you to easily move between various databases.

about the costs of having such a remote system. It is the responsibility of developers using such a framework to remember the costs associated with making remote calls and to program accordingly.

Porting CRM to Sajax PHP

In order to port the CRM application to Sajax, we will be changing the way we think about the application. Back in the chapters on JavaScript toolkits and frameworks such as Dojo and Prototype, we were very focused on the front-end HTML and JavaScript code, and little was mentioned about the back end. Now we will focus behind the scenes, and will use Sajax to generate the front end as much as possible. This means that instead of writing all of the JavaScript ourselves, we will have helper functions that do some magic for us.

Building Back End Functions

Let us create PHP backend functions for the Zip to City/State service. We will build the get_city_state() function that will use a MySQL database to return the city and state for the given zip code. We will place this functionality in its own PHP file, zipService.sajax.php, and will include it from our web-facing PHP code.

We'll start with the small things first. We define some constants to hold information on the database itself:

File 21

```
define('DB_HOST', 'localhost');
define('DB_USER', 'crmuser');
define('DB_PASS', 'crmpasswd');
define('DB_NAME', 'crm');
```

Then we create the get_city_state() method:

File 21

```
function get_city_state($zip) {
        if (!mysql_connect(DB_HOST, DB_USER, DB_PASS)) {
                bail("Could not connect to MySQL");
        }
        if (!mysql_select_db(DB_NAME)) {
                bail("Could not use the " . DB_NAME . "  database in MySQL");
        }
        $q = sprintf("SELECT city,state FROM zips WHERE zip = '%s'",
                mysql_real_escape_string($zip));
        $r = mysql_query($q);
        $row = mysql_fetch_assoc($r);
        if ($row['city'] && $row['state']) {
                $return_string = $row['city'] . "," . $row['state'];
        } else {
                $return_string = "Could not find a city or state for this zip code";
        }
        mysql_free_result($r);
        return $return_string;
}
```

There are quite a few lines of code here, but it is familiar to most PHP developers. We start off by connecting to MySQL and selecting the CRM database with mysql_connect(), and mysql_select_db(). We then build the query making sure to escape the input via mysql_real_escape_string(). We escape the input string to provide some protection against cross-site scripting and SQL injection attacks.[2] Finally, we fetch a row from the database via mysql_query(), and mysql_fetch_assoc().

After all of this, we either have a matching city and state to return, or we pass back an error message. Since we are good developers, we don't forget to free up our resources with mysql_free_result() before returning our results. This ensures that any memory being hogged by our results is eagerly released. We don't necessarily need to call this for the script you see here, as the results are automatically released upon termination of the script, but for the sake of explicitness, we include the call.

You may have noticed the helper function, bail(), that shouts back errors to the browser if there are serious system issues (e.g. the database is down). This is one of the helpful things about integrating Ajax directly into the server-side implementation framework. When bad things happen during the server's execution of an asynchronous callback, it helps to have built-in channel for expressing the error information back to the browser.

[2] For more information about these kinds of attacks, see XXX and XXX.

File 21

```
function bail($message) {
        header('Content-Type: text/html; charset=utf-8');
        echo "<html><head><title>Zip Error</title></head><body><h2>$message</h2>" . mysql_error
        die();
}
```

Migrating to Sajax

Our backend code is written, so now we move to the client browser view. We'll create a PHP file that creates the HTML for display, as well as exports our server functions to the browser as JavaScript methods. In figure_ed_screen_sajax.php, we include the main Sajax PHP module ("Sajax.php"), as well as the Zip Service code that we created earlier ("ZipService.sajax.php"). In addition, we have to initialize Sajax and choose the function that we want to be able to call from the client. We "export" the method via sajax_export("get_city_state")().

File 17

```
require_once("sajax/php/Sajax.php");
require_once("zipService.sajax.php");
sajax_init();
//$sajax_debug_mode = 1;
sajax_export("get_city_state");
sajax_handle_client_request();
```

What about the sajax_handle_client_request()()? That is where the magic happens. If we take a step back and think about what actually happens at runtime, we realize that for this to work, three things have to be true:

- Something has to generate the client-side Ajax call
- Something has to be listening on the server for callback from the generated method
- The listener has to be able to invoke the original server-side method (with parameters) based on the callback from the client, and return the results

This is the job of sajax_handle_client_request()(). Though this is standard boilerplate code that doesn't change, and which you don't have to write, it is still important to understand what is happening here. This is true both for debugging purposes, as well as making appropriate use of the framework. First, the method harvests the server-side function name and arguments from specific parameters of the request. It uses those to dynamically invoke the server-side function. Notice also that for GET requests, the method makes sure (as much as is possible) to prevent client-side caching of the results, where as for POST requests,

it doesn't bother. This is because the HTTP specification notes that POST responses are not, by default, cacheable, so there is no need to specify the various no-cache headers as in the GET version. [3]

File 18

```
function sajax_handle_client_request() {
        global $sajax_export_list;
        $mode = "";
        if (! empty($_GET["rs"]))
                $mode = "get";
        if (!empty($_POST["rs"]))
                $mode = "post";
        if (empty($mode))
                return;
        if ($mode == "get") {
                // Bust cache in the head
                header ("Expires: Mon, 26 Jul 1997 05:00:00 GMT");    // Date in the past
                header ("Last-Modified: " . gmdate("D, d M Y H:i:s") . " GMT");
                // always modified
                header ("Cache-Control: no-cache, must-revalidate");  // HTTP/1.1
                header ("Pragma: no-cache");                          // HTTP/1.0
                $func_name = $_GET["rs"];
                if (! empty($_GET["rsargs"]))
                        $args = $_GET["rsargs"];
                else
                        $args = array();
        }
        else {
                $func_name = $_POST["rs"];
                if (! empty($_POST["rsargs"]))
                        $args = $_POST["rsargs"];
                else
                        $args = array();
        }
        if (! in_array($func_name, $sajax_export_list))
                echo "-:$func_name not callable";
        else {
                echo "+:";
                $result = call_user_func_array($func_name, $args);
                echo $result;
        }
        exit;
}
```

With this code in place, the work of the developer is largely complete. Since so much of the Sajax framework is handled in the bridge code, your job is largely one of configuration (denoting which methods are to be exported). However, around 80 or so lines of JavaScript are required in the browser to wire all this up; one line of PHP code is all that is required to generate and embed the scripts.

[3] http://www.intertwingly.net/blog/2005/03/16/AJAX-Considered-Harmful

Sajax Debug Mode

By setting $sajax_debug_mode = 1;, Sajax will provide you with helpful tracing information during the execution of code within the page. The framework delivers the information via alert()() calls which pop up modal dialog boxes to display the information. The type of information you'll see includes:

- notification of the begin and end of server callback functions
- the name and parameters of the server function to be called
- the raw result of the callback

Other responses are also possible. Be forewarned that turning on debug mode will severely hamper a users ability to actually use the application, so only use it for designated testing purposes.

File 17
```
<?php sajax_show_javascript(); ?>
```

You can examine the generated JavaScript code by doing a View Source on the page. In addition to a bunch of standard code for instantiating the XHR object and wiring up its state callbacks, you will also see methods generated specifically by your sajax_export() calls from before. Each method that was exported gets a client-side helper method whose name is x_(name of original function)(). In our case, the function is called x_get_city_state(), shown here:

```
function x_get_city_state() {
                                        sajax_do_call("get_city_state", x_get_city_state.argume
                                }
```

What is the x_get_city_state.arguments() all about? To allow for a variable length parameter list, we are packaging up all the inputs to the method into a single collection of values. These values mimic the server-side function definition exactly, with one addition. To enable the full Ajax lifecycle of a Sajax method, we have to provide an extra parameter, which is a function to use as a callback when the request returns without an error. This method harvests the results of the server call and performs the client-side work to display and/or utilize the data. The function we have been using to this point is assignCityAndState(), which

we will just reuse in this context.

File 17
```
function assignCityAndState(data) {
        if (data.indexOf(',') > 0) {
                var cityState = data.substring(1).split(',');
                document.getElementById("city").value = cityState[0];
                document.getElementById("state").value = cityState[1];
                document.getElementById("zipError").innerHTML = "";
        } else {
                document.getElementById("zipError").innerHTML = "Error: " + data;
        }
}
```

Since we are leaving the main part of our HTML identical to the early Ajax examples, we can wrap these calls with our faithful getZipData():

File 17
```
function getZipData(zipCode) {
        x_get_city_state(zipCode, assignCityAndState);
}
```

Gaining and Losing

So there you have it. We have shown how you can take the Sajax framework, and export server-side functions in a very simple manner. Sajax really is simple to use, but there are some drawbacks. The main drawback is that you only have the ability to return simple types from your exported functions. You can't return a rich object and have it jump into a JavaScript object (via JSON or anything else). This means that you may often create wrapper functions around existing server-side code to wrap their return types with simple String based information which can be parsed manually on the client.

Similarly, other frameworks (like Dojo) offer transparent failover support for older browsers. For example, Dojo can switch to use iframes for remoting when the XHR object is not available. Sajax provides no such support; it is a no-frills framework designed to make it easy to take advantage of Ajax features in modern browsers. What you gain is simplicity: a standard programming model with little to no JavaScript code to be written.

9.3 XOAD

Sajax isn't the only PHP Ajaxian framework in town. A newer kid on the block is XOAD. We are going to port our CRM application from the Sajax version, and get a good view of the similarities and differences between the two popular frameworks.

Sajax Could Work This Way

At this point in time, Sajax could work with this code too. A simple way to get it to work is to create a wrapper function that we utilize like this:

```
function get_city_state($zip) {
        return ZipService::get_city_state($zip);
}
```

Soon we will change the class more though for XOAD, and it will no longer work with Sajax.

From Procedural to OO

XOAD is similar to Sajax in that it is also uses an ORB-based remoting model where you bind your JavaScript layer to your server-side code. You would think that we would be able to use exactly the same Zip Service that we already created for the Sajax version. This isn't going to be the case, due to the fact that XOAD cares about classes and OO. We will not export just methods, but will give XOAD objects and classes. This means that we need to change the Zip Service to be a class.

Changing the Back End

We can do this in a slightly cheeky manner. We are going to take the get_city_state() and bail() functions and make them static methods in a zip service class. We wrap the code in class ZipService { ... }, and we make the functions static by adding the static keyword before their definitions (so we have static function get_city_state($zip) {...}).

The one change we need to make to the back end for XOAD is the addition of metadata to the class that describes what should be exported. This metadata gets added via a simple instance method on the zip service:

File 19

```
function najaxGetMeta() {
        NAJAX_Client::mapMethods($this, array('get_city_state'));
        NAJAX_Client::publicMethods($this, array('get_city_state'));
}
```

You have some options on what you want to export. In our example, we give the map of methods that we want to export, and we assign the access to public methods. You can access private methods via

XOAD_Client::privateMethods(), and variables can be accessed directly via XOAD_Client::privateVariables() and XOAD_Client::publicVariables(). Any OO purist will tell you that doing so violates the principles of encapsulation: namely, private members and data fields should be accessible only by the defining class or specifically trusted entities. Therefore, be careful when utilizing these methods and ensure that you are getting the functionality you actually need.

Back to Front

We start in on the client side as we did with Sajax. We load everything we need, and define the base directory for all things XOAD. In this case, we are using a subdirectory called 'najax'.

File 15

```
define('NAJAX_BASE', 'najax');
require_once('najax/najax.php');
require_once('zipService.najax.php');
NAJAX_Server::allowClasses('ZipService');
if (NAJAX_Server::runServer()) {
        exit;
}
```

We will also register the classes we want to be remotable. It it not technically necessary to do this, but it is considered the polite thing to do. XOAD keeps two hashes full of classes, one for allowed classes and one for denied classes. Calling methods on denied classes results in an error; calls to methods on allowed *or unassigned* methods will proceed. However, in keeping with suggested usage, we'll register the ZipServer class with XOAD_Server::allowClasses().

XOAD sets up XHR requests to come back to the same PHP server page. This means that our PHP page is accessed in two modes. One is to display the main page, and the other is to access the callback function. The check in XOAD_Server::runServer()() is there to handle the XHR request; it returns false immediately if the request is not an XHR callback. Otherwise, this method fires off the bound server methods according to the request parameters and returns the results.

Once again we are quickly done with the PHP header code, and we are into the HTML itself. We need to include all of the XOAD helper JavaScript code, which is done at the top of the HTML head element:

File 15

```
<?= NAJAX_Utilities::header('najax') ?>
```

XOAD Serializer

At this point, XOAD uses a serializer object to be able to convert between the two worlds. We found an issue when running on PHP 5.1, and had to change the Serializer.class.php file so that the function function serialize(&$var) became function serialize($var) (i.e. we removed the ampersand). PHP 5 has different rules for handling pass by reference semantics. The error we were receiving was:

```
PHP Fatal error:  Only variables can be passed by reference in /path/to/najax/classes/Seria
```

We mentioned that XOAD is all about classes and objects, not just functions. To register a class, and have access to it via JavaScript, you just need another helper function:

File 15
```
var obj = <?= NAJAX_Client::register(new ZipService()) ?>;
```

We are registering a named object from the server, but you can also register anonymous items such as in-line lists. To do that you would just do something like:

```
var arr = <?= XOAD_Client::register(array(1, "bob", array("nested"))) ?>;
```

To handle errors that may occur, you follow a naming convention that allows you to have handlers for every method that you call. The format of the handler in question is obj.on(Name of method)Error(), where the first character of the method name gets uppercased. We handle errors in our application with:

File 15
```
obj.onGet_city_stateError = function(error) {
        document.getElementById("zipError").innerHTML = "Error: " + error.message;
        return true;
}
```

The final piece of the pie is to wrap the getZipData() once again to tie into our object:

File 15
```
function getZipData(zipCode) {
        obj.get_city_state(zipCode, assignCityAndState);
}
```

Returning Rich Types

We mentioned that XOAD is able to deal with richer return types that Sajax. Let's change our code to try that out for size. To do this, we will

change get_city_state() to return an object of type ZipCityState. This is a structure that has all of the data needed, instead of having a strange String representation that you then need to parse on the client side.

The ZipCityState structure is a simple type. We just give it some public variables that can store and retrieve our data. Why even bother with accessors and mutators when it is this simple? (We can sense the OO purists out there squirming).

File 20
```
class ZipCityState {
        var $zip;
        var $city;
        var $state;
        function ZipCityState($theZip, $theCity, $theState) {
                $this->zip = $theZip;
                $this->city = $theCity;
                $this->state = $theState;
        }
}
```

Now we have a rich type to pass around between layers. We can create an object of this type in get_city_state() using the constructor provided above in the ZipCityState class.

File 20
```
if ($row['city'] && $row['state']) {
        $return_object = new ZipCityState($zip, $row['city'], $row['state']);
} else {
        $return_object = NULL;
}
```

Our back end code has now been updated to return the rich object, so we need to change our browser code to be able to understand this object when it comes back. Remember, the original version expects a custom string representation of the data which it has to parse manually. The best thing about this example is that we are hardly having to change anything, and in fact we get to delete the string parsing code. XOAD is handling the marshaling of the return type for us. It is creating a ZipCityState JavaScript object that has the same methods as the PHP version.

This means that the only change we make is to the assignCityAndState() JavaScript function. XOAD passes the return from the PHP get_city_state() to assignCityAndState(). It just so happens that it now gets the rich ZipCityState, and we can use this object to get the city and state data by simply using zip.city and zip.state. It looks like this:

File 16
```
function assignCityAndState(zcs) {
        if (zcs.city) {
                document.getElementById("city").value = zcs.city;
```

```
                document.getElementById("state").value = zcs.state;
                document.getElementById("zipError").innerHTML = "";
        } else {
                document.getElementById("zipError").innerHTML = "Error: " + zcs.zip;
        }
}
```

So there we have it. XOAD successfully managed to take a rich return type and generate a JSON representation to pass down to the client. This allowed us to map object return types versus simple strings and the like. You probably don't want to get too carried away though. While it is theoretically possible to create insanely complex return types, with nested complex structures for data, this can lead down a long road of debugging, testing, and possibly even modifying the marshaling code buried inside of XOAD. Besides, even if the marshaling code handled the data structures without problem, large types still take up a lot of bandwidth. Keep it simple, and everyone is happy.

There is More to XOAD

This concludes the port over to XOAD, and we have seen how it is an OO based system versus the function-based structure of Sajax. The XOAD serializer allows you to return rich objects that will get converted to JSON objects that the browser JavaScript engine can consume.

There are other interesting sides of the XOAD library that we haven't seen in this use case. One of these is *XOAD Events* which and allows you to fire events from one computer and catch and process them on another. This is all done by using an observer pattern, and having one piece of code firing events, and another listening for them. This is useful for Ajax applications that need to be very responsive to data being passed between tier (like a chat client, for example).

9.4 Wrapping Up

We have shown you two of the most popular PHP-based Ajax frameworks. These frameworks amply demonstrate the power of integrated Ajax code; the simplicity of the model is evident. You never have to leave the cozy confines of PHP to achieve dramatic Ajax results. In fact, you don't even have to look at the JavaScript if you don't want to. However, just because these frameworks *can* hide the details of JavaScript on the client, that doesn't mean that you have to ignore it yourself. There can be quite a lot of benefit to leveraging a high level abstraction layer like

Sajax or XOAD, but manipulating the DOM directly with JavaScript to achieve more complex client-side behavior as well.